NPS ARCHIVE
1965
DRURY, W.

A FORTRAN PROGRAM FOR PERMUTED TITLE INDEXING

WILLIAM R. DRURY

1965

Library
U. S. Naval Postgraduate Schoo
Monterey, California

DUDLEY KNOX LIBRARY
NAVAL POSTGRADUATE SCHOOL
MONTEREY CA 93943-5101

1500/Nc13
Ser: 577.3

U. S. NAVAL RESERVE OFFICERS TRAINING CORPS
THE UNIVERSITY OF KANSAS
LAWRENCE, KANSAS

IN REPLY REFER TO:
NROTCKU/HHD:rr
1520
7 December 1965

From: Commanding Officer, NROTC Unit, University of Kansas, Lawrence, Kansas
To: Superintendent, Postgraduate School, Monterey, California

Subj: Completion of course report; forwarding of

Ref: (a) USNPGS INST P5000.2B of 14 FEB 65

Encl: (1) Thesis (2 copies) - 1 Copy only for 038.
(2) Official Transcript
(3) NPS Form #100
(4) Copy of Bupers Order 152394 w/endorsements

1. In accordance with reference (a), enclosures (1) through (4) are forwarded herewith for the below listed officer:

LT William R. DRURY, 624483/3100, USN

A FORTRAN PROGRAM FOR PERMUTED TITLE INDEXING

by

William R. Drury

B.S., United States Naval Academy, 1958

Submitted to the Department
of Chemical and Petroleum
Engineering and the Faculty
of the Graduate School of
The University of Kansas in
partial fulfillment of the
requirements for the Degree
of Master of Science

November 1965

Library
U. S. Naval Postgraduate School
Monterey, California

DUDLEY KNOX LIBRARY
NAVAL POSTGRADUATE SCHOOL
MONTEREY CA 93943-5101

ABSTRACT

Raw data pertaining to thesis topics in the fields of Chemical and Petroleum Engineering, submitted to 144 universities and other institutions of higher learning, are indexed by keywords-in-context and displayed permutedly. The printed output reference listing is entered by keyword. Serial references to author, school, and hardcopy may be read directly.

Reference listings were prepared using an IBM 7040 Fixed-word-length Computer. The computer programs are written in Fortran (IV) computer language.

ACKNOWLEDGMENTS

The author wishes to express sincere appreciation to Dr. Floyd W. Preston whose guidance, wise counsel, patience, and humor were ever-present in bringing this thesis to completion.

Also, Dean Wiley S. Mitchell, Associate Dean of the School of Business, and Dr. Charles F. Weinaug, Chairman of the Department of Petroleum Engineering, are due many thanks for their efforts on behalf of the Petroleum Management program. To Mr. Maung Maung Win of the Chemical Engineering Department are extended sincere expressions of appreciation for the kindness shown in permitting the author to use his extensive data collection for this study.

Special recognition is given to the United States Navy whose sponsorship made this study possible.

TABLE OF CONTENTS

Chapter Page

I INTRODUCTION....................................1

Purpose....................................1

Description of Terms....................................1

Permuted Title Indexing....................................2

Origin....................................3

II CONSIDERATIONS IN ESTABLISHING AN INFORMATION RETRIEVAL SYSTEM....................................5

General....................................5

Additional Considerations....................................6

Implications to Military Situations....................................8

III A PROBLEM IN PERMUTED TITLE INDEXING....................................10

Data....................................10

Method of Solution....................................10

Record Processing....................................11

Error Detection....................................11

Keyword Identification....................................12

Tape Loading....................................13

Sorting....................................13

Write-out Procedures....................................14

Description of Programs....................................14

IV ANALYSIS OF PROCEDURES AND COMPUTER TECHNIQUES....20

Utilization of Computer Time....................................21

Interpretation of Output....................................24

V CONCLUSION....................................25

Summation of Findings....................................25

Projections of the Future....................................26

TABLE OF CONTENTS (continued)

Chapter Page

Food for Thought..............................26

REFERENCES..28

BIBLIOGRAPHY......................................29

APPENDIX A..31

Fortran Notation..............................31

Flow Chart for Mainline Program...............33

Source Deck Listing (Mainline Program)........39

Flow Chart for Subroutine KICK................45

Source Deck Listing (KICK Subroutine).........46

Flow Chart for NBRT Subprogram................47

Flow Chart for KSKOL Subprogram...............47

Source Deck Listing (NBRT Subprogram).........48

Source Deck Listing (KSKOL Subprogram)........49

Flow Chart for Master Tape Write-out..........50

Source Deck Listing (Master Write-out)........51

Flow Chart for Permuted Title Index Write-out...52

Source Deck Listing (Permuted Title Index Write-out)....................................54

Flow Chart for Author Listing Write-out.......56

Source Deck Listing (Author Write-out)........57

Source Deck Listing (PACK Subroutine).........58

Source Deck Listing (UNPACK Subroutine).......58

Control Cards for SORT........................59

Discard Dictionary............................60

APPENDIX B..61

TABLE OF CONTENTS (continued)

Chapter Page

Sample Input Data.............................61

APPENDIX C....................................62

School Dictionary.............................62

Permuted Title Index..........................62

Master Record Bibliographic Listing.........62

LIST OF FIGURES

Figure Page

1 Sample Record Formats........................16

2 Generalized Flow Chart......................19

Chapter I

INTRODUCTION

Purpose of Investigation Information accumulation, once the very object of man's formal education, is rapidly becoming a giant boulder to be thrown in the path of man's search for meaningful data. The volume of printed matter on virtually any subject grows hourly at a swift pace and man has been slow to grasp this reality.

This thesis deals with one aspect of information handling wherein computer processing techniques are utilized to perform cataloging, alphabetizing, indexing, and printing of a large volume of historical data pertaining to writings in a specialized field of endeavor (ie: Chemical and Petroleum Engineering). It is the author's aim to determine whether it is feasible to create a permuted title index with an engineering oriented, fixed-word-length digital computer. If so, such a program will be written.

Description of Terms Used "Permuted Title Indexing" and "Keyword-in-Context Indexing" (KWIC) are synonomous and refer to the procedure of shifting sequences of words. The important word is printed in a designated keyword column while retaining its contextual significance through reproduction of surrounding words. "Discard words" are the obverse of important words or "keywords." "Discard words" simply are passed-by in the indexing procedures. Notation used herein for computer programs and construction

of computer programs is done in the Fortran (IV) computer language.[1] One exception is the PACK subroutine which is written in the MAP computer language.[2]

Permuted Indexing as a Part of the Information Handling Spectrum

Information handling = Documentation
+
Information retrieval
+
Data processing
+
Information processing[3]

The above equality represents the information handling spectrum. Permuted title indexing is but a small portion of information retrieval, and while the ultimate, futuristic information handling systems may well be capable of completely automating data-indexing, the current practicalities (machine capabilities and economics) point toward hard copy index listings rather than machine-stored data which may be indexed each time an inquiry is presented on the subject matter which is in machine memory. Carried one step further, the futuristic system should easily be able to produce not only indexes, but also abstracts and full-text reproductions. While scientists and humanists alike should await with great anticipation the coming of the automated research era, there remains today volume after volume of literature lists which may be indexed with the machines of today for the benefit of today's researcher. This is the problem to which the author addresses himself.

Permuted title indexing has the great advantage of

being relatively inexpensive when compared to stored indexing procedures. However, the ease of creating permuted title indexes is counter-balanced by the lack of any qualitative judgements as to the value of the word being indexed in relation to its possible importance to the user or researcher. The only determination made is whether the word is to be kept (a keyword) or to be discarded. This determination, while discretionary on the part of the programmer, is nonetheless completely quantitative in nature.

Origin of Permuted Title Indexes One of the earliest ventures in machine-generated-indexes was described to a meeting of The American Chemical Society in Atlantic City, New Jersey, on September 14, 1959, by Mr. Hans Peter Luhn of the International Business Machine Corporation.[4] It was on this occasion that the word KWIC was added to the computer field's dictionary of buzz words. (While often associated with IBM, KWIC is not a trademark of that company.) In the six years following the introduction of KWIC by Mr. Luhn, similarly constructed indexes have been generated in many segments of industry and education. Three examples of such applications are:

Chevron KWIC Index [5]

Journal of Association for Computing Machines [6]

Kansas Slavic Index [7]

The first is an index of articles published in The Journal of Petroleum Technology and The Society of Petroleum Engi-

neers Magazine of interest to the Chevron Oil Company. The second example is an annual recapitulation of all articles in a trade publication. The third is in the Kansas State University and University of Kansas libraries as an ancillary aid to researchers in the field of Slavic writings.

These three examples serve to point up the wide range of subjects which may be served by permuted title indexes. While each example is somewhat different in format and construction, the techniques employed do not vary widely.

Chapter II

CONSIDERATIONS IN ESTABLISHING AN INFORMATION RETRIEVAL SYSTEM

General Requirements Any system to retrieve information must be designed to fit the problem at hand. This can be accomplished in one of two ways. First, the system may be designed from the beginning or secondly, a more general application may be modified to fit the problem. To attempt to design an information retrieval system which will apply to all categories (medicine, business, refining, engineering, etc.) is to presume that the end-user will have the requirement to know all things about all categories. This presumption is falacious with possibly the exception of one or two huge libraries which might serve as repositories for all the world's written works.

In view of this, the parameters of any problem in information retrieval may be reduced to three: 1) the data which is available 2) the processing system or systems which may be available to accomplish the task 3) the time dimension or urgency of the matter. The data parameter encompasses determination of file size (how much data should be indexed), conversion to a format which is compatible with the processing system to be used, assignment of weighting factors to distinguish the importance of one piece of data in relation to others being indexed (where appropriate), and constraints which are to apply to exception data (what field of endeavor is free of exceptions!).

The processing parameter is usually dictated by the available machine capability. Of course, a large indexing operation could require purchase or rental of equipment to perform the specific task at hand. In this case, computer hardware configurations having variable-word-length features, storage capacity to fit data collection, and high-access-speed to storage would play a large part in the selection of a computer to perform the task. The parameter of time is simply a pressure on the decision-makers responsible for the information handling project. Ample time allows for optimum data collection, machine selection, and output preparation. Stringent time requirements may adversely affect each element.

Additional Considerations Future expansion of data files imposes the requirement for elasticity in the construction of the initial indexing procedure. This is often called "open-file" construction. When the possibility exists that a particular data collection will grow over an extended period and that repeated indexing will be required (i.e. monthly, bi-monthly, etc.), system design must provide for the merging of new records with old. While much of the merging and sorting may be accomplished by machine, there remains the problem of how new data is to be merged-whether the criterion will be man-assigned codes or whether the computer is to be programmed to perform recognition chores. The latter is certainly desirable when the data may be recognized and stored without inclusion of a value

descriptor. However, when relative-judgements are required, man is still required to assign the "opinion" code.

The permuted-title-index method of expediting information retrieval is one step toward the day when it will be the function of the library to retrieve information, thereby freeing the researcher to spend his time digesting and evaluating the information in the field under study. "Research workers today, in danger of suffocation under the weight of published material, should not have to do the extra work of discovering what documents are actually relevant - searching the literature - unless they have some particular reason for wanting to do so." [8]

As the trend continues toward automated library service, information retrieval will be greatly facilitated, but new problems will arise. Specifically, the economics of running a large computer-oriented library solely for research are of a magnitude to provoke extensive debate, as the concept is not yet universally accepted. Coupled with the economic questions are the very real questions of who will operate this advanced system of high speed data retrieval. The thought of having the average user push buttons to operate a system with which the user is not totally familiar appears impractical and leads to the conclusion that trained information retrieval personnel will be required to render such an advanced system proper handling and efficiency of operation. [9]

Implications of Information Retrieval to Military Situations "The real expense of information comes in not having it." [10] This quote actually comes from a trade publication describing efforts by the Goodyear Rubber Company to keep pace with the exploding volume of technical information pertinent to the rubber industry. However, the quote states a truism of military doctrine which over the years has been expressed in a variety of patriotic and political slogans -

> "To be forewarned is to be forearmed"
> "Know your adversary"
> "In war, the winner spends too much,
> the vanquished spends too little"

Each of these expressions (and many more of similar intent) deals with knowledge of the opponent and presupposes a complete knowledge of the speaker's own internal operations.

Today the "expense" of missing information no longer can be calculated in terms of missing intelligence or poor scouting reports. The electronic, atomic, computerized defense establishment which this country has acquired for itself also demands a high degree of information gathering in terms of what inventories are available, where they are located, whether parts are interchangeable, what is the best delivery path, etc. Thus, the techniques for collecting data, indexing, publishing, and distributing large numbers of cross-reference manuals to end-users

around the world find increasing application in the military as well as civilian industry.

Chapter III

A PROBLEM IN PERMUTED TITLE INDEXING

Data A collection of Chemical Engineering M.S. and Ph.D. thesis titles with author names, school, and year of publication exists in the Department of Chemical and Petroleum Engineering. This collection, comprised of 3000 titles, has been assimilated from 144 universities in the United States and Canada and has been stored on punched cards. Each record consists of at least three punched cards and ranges to a maximum of six cards. The format of the input data is listed below.

1st card	Serial code (Columns 1-4)
	Author name (Columns 6-38)
	Year of publication (Columns 40-43)
2nd card	Title (Columns 7-55)
3rd card	Title continued (Columns 8-55) optional
4th card	Title continued (Columns 8-55) optional
5th card	Title continued (Columns 8-55) optional
Last card	School name (Columns 9-48)

Appendix B on page 61 shows a print-out of sample input data. The University of Kansas computer (IBM 7040-16K) was utilized to convert the data to printed format and to construct a permuted title index.

Method of Solution The problem is subdivided into six general sub-areas for discussion:

Record processing

Error detection

Keyword identification

Tape loading

Sorting

Write-out procedures

A general flow chart is shown on page 19 as Figure 2.

Record Processing A set of cards comprising a single record is read into the computer. Based on the pre-assigned format for each card in a set, the computer stores the information from each card, formulates the code (serial number of title, year of publication, school code number) which will be carried forward in each step of the program, searches for words, tests the words found against a dictionary of discard words, and records the information on three tapes: a master record tape, a keyword tape, and an author tape.

This procedure is repeated until the last card, which is coded "last card," is read. The main-line computer program is listed in Appendix A, pages 33 through 44.

Error Detection As each card is read, its format is compared with the pre-assigned formats for each card in the set, and, if an exception exists, the exception card is printed out with a message indicating whether the error exists in author, title, or school card. Corrective action is then taken manually by repunching the data card which has been found to be incompatible with the specified format.

Spelling errors are not detected by this procedure and, in fact, are ignored in the preparation of the per-

muted index. One exception to the spelling error rule exists when formulating the school code number. A list of all schools applicable to the problem is stored in the computer. The school data card information is compared to this list until an exact comparison exists. The code corresponding to the school, as listed in Appendix C, page 62 , is then assigned. Should an exact comparison not exist, an error message will be printed showing the school data card which is incompatible with the school dictionary file. If the school simply is not listed, an additional entry must be added to the school dictionary. If the school data card is misspelled, repunching is required.

Keyword Identification When a record has been determined to be in proper format, the title cards are searched character by character. Any combination of letters with a blank character at both ends of the combination is considered a possible keyword which is then compared to the words in the discard dictionary. If the combination of characters being tested corresponds with a word in the discard dictionary, no further action is taken and the program proceeds to locate the next succeeding group of characters in the title cards. If the combination of characters does not coincide with any discard word, a keyword is determined and is stored on the tape containing keywords, location of the first character of the keyword in relation to the full title, and the serial code. This procedure is repeated on each of the four title data arrays until two characters in succession are deter-

mined to be blank. Thus, if a complete title exists on a single input data card, the program will sense the end of the first card when 1) the column count reaches the limit prescribed for the card being tested or 2) two successive blanks are determined. At this point, the program will check in succession the first column of each of the remaining title data arrays to determine the existence or non-existence of additional title information. If non-existence is determined in each remaining array, end of title is confirmed and the program proceeds to the next element.

Tape Loading Three tapes are loaded with data to be used in printing output listings. First, a master bibliographic tape is prepared which contains serial code, full title, and author as a single entry. Second, a keyword tape is prepared. Each keyword which is determined is loaded as a single entry on this tape. Serial code and keyword location are carried along as mentioned above. Third, an author tape is prepared consisting of serial code and author name.

Sorting The master bibliographic tape is loaded in order by serial code and no sorting is performed on this tape. The keyword tape is sorted alphabetically using the IBM Generalized Sort System [11] for the 7040 Computer. This sort program is shown in Appendix A, page 59. The author tape was not sorted due to the fact that serial codes are assigned alphabetically by author name. However, if the

file were increased and serial codes were assigned on a basis other than alphabetic-author, this tape is so constructed that it may be sorted by the same sorting program that is used to sort the keyword tape.

Write-out Procedures Separate write-out programs for each output tape are listed in Appendix A on pages 50, 52 , and 56. The programs for the master bibliographic tape and author tape are straightforward and involve only read-write operations within the computer.

The program for writing the KWIC index requires both the sorted keyword tape and master bibliographic tape as input data to the computer. The keyword tape is read, the master tape is searched to find the bibliographic listing corresponding to the code applicable to the keyword being listed, the title is positioned in a holding array within the computer by the keyword location, and the permuted title is then written out.

When a keyword is located near the end of a lengthy title, much of the meaning of the title may be lost due to truncation of the title. In this event, provisions are included in the write-out program for the keyword tape to "wrap-around" the first forty characters of the title.

Description of Programs The computer instructions for the problem are divided into five independent segments:

1- Main program to process data and load tapes
(Appendix A, page 33)

2- Sorting instructions
(Appendix A, page 59)

3- Write-out of master bibliographic list (Appendix A, page 50)

4- Write-out of permuted title index (Appendix A, page 52)

5- Write-out of author list (Appendix A, page 56)

The Main computer program has the basic functions of checking and converting. Checking: Each data card must be checked for correctness of the format, and notice of error must be returned to the programmer by a computer generated error message. Converting: Once the data has been transferred from the storage medium of punched cards to the medium of electronic core storage, the physical restrictions of record size (i.e. eighty columns of punched data per card) are removed, and records of greater length than eighty characters may be established in the computer. As keywords are identified, the information is transferred from one storage medium (core) to another (tape). Figure 1 at the top of the next page describes the final format of the data as it is transferred from the computer and stored on tape.

Four subprograms are utilized in connection with the main program:

1- The NBRT function subprogram is used to determine whether a character being tested is numeric or non-numeric. The answer returned to the main program is either true or false. (True if character under test is a number; false if not a number).

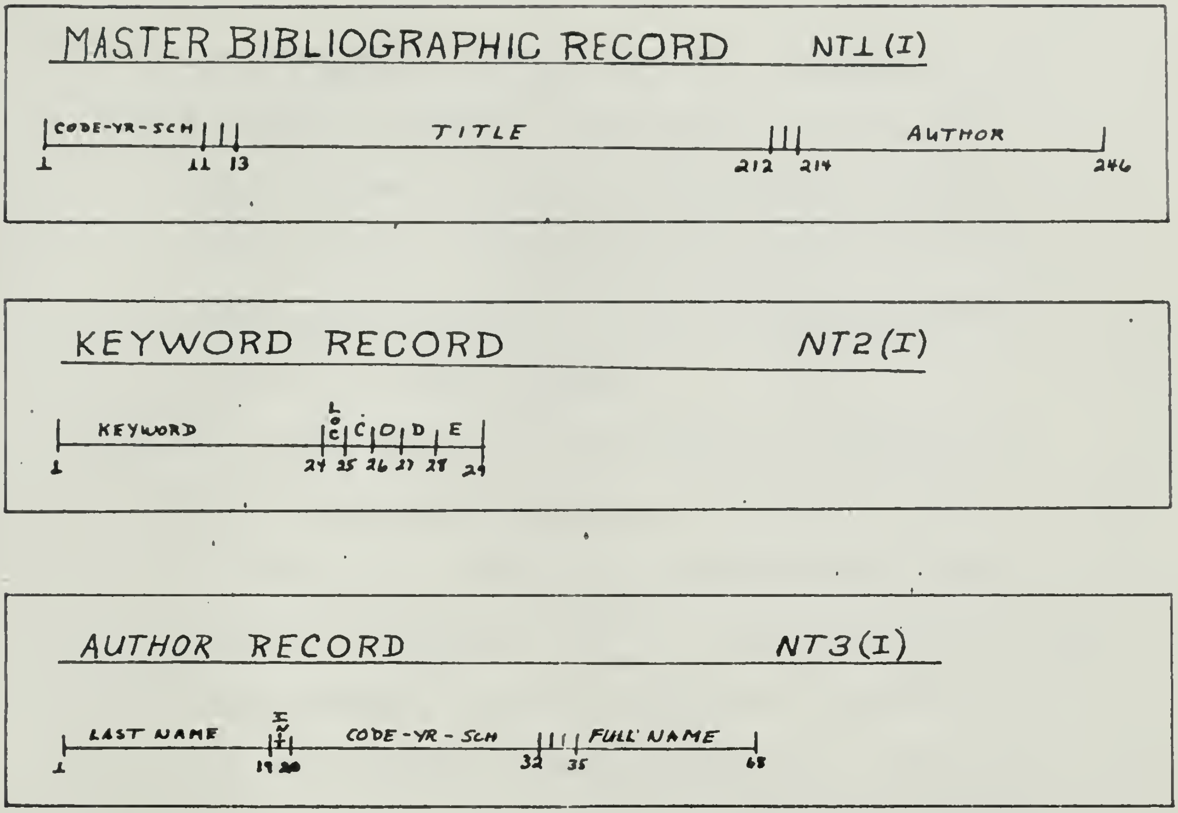


FIGURE 1

2- The PACK subprogram, which is written in the Macro Assembly Program (MAP), is used to speed-up the internal search procedure which determines school-code numbers. This subprogram condenses or PACKS characters which are stored one character per computer word to a maximum of six characters per computer word. Thus, the school-data-card information which is read into the computer on a character by character basis may be converted to allow faster comparison to school dictionary which is read and stored

six alphabetic characters per computer word.

3- The KSKOL function subprogram is used in the formulation of the serial-year-school code number. The program searches the school dictionary and returns the school code number to the main program.

4- The KICK subroutine subprogram performs the decision-making function of whether a group of characters under test constitutes a discard word or a keyword. If the group of characters being tested does not correspond exactly to any word in the discard dictionary, the word is returned to the main program for continued processing. Otherwise, a zero signal is returned to the main program to initiate search for the next group of characters.

The second segment of computer instructions is the Sorting instructions. The tape containing the information to be sorted is mounted on the tape unit specified by the programmer, and the control cards for the IBM Generalized Sort System are read into the computer. When sorting is complete, the sorted tape will be located on the tape-drive assembly selected by the computer - the identification of which will be listed on the computer console typewriter record.

The third, fourth, and fifth segments of the instructions are programs to list or print-out the information

stored on the three tapes involved. Each write-out program requires its corresponding tape to be mounted on a specified tape drive assembly as input data to the write-out program. The write-out program for the permuted title index also requires the master bibliographic tape as input data as mentioned above.

GENERALIZED
FLOW CHART

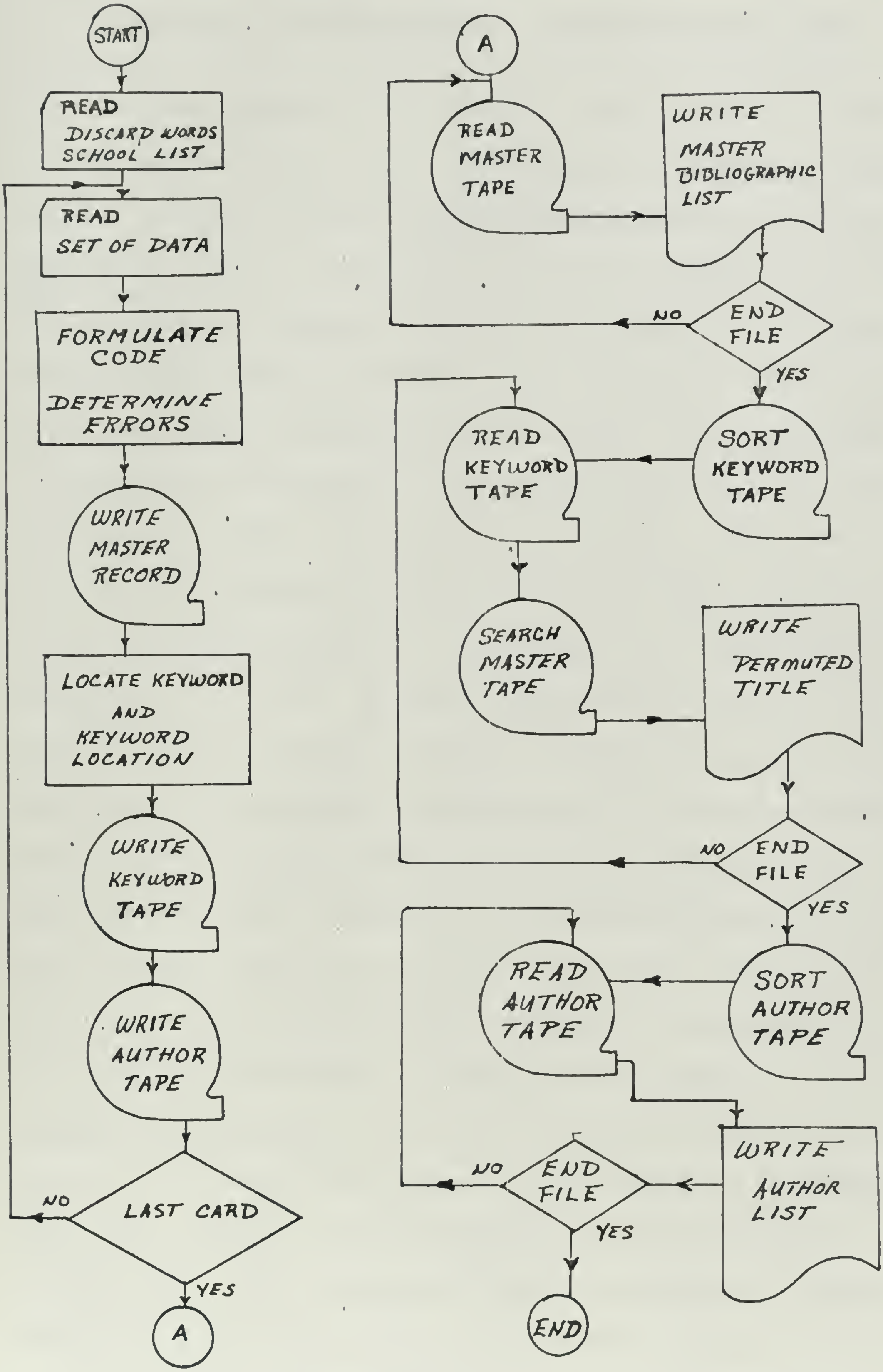


FIGURE 2

Chapter IV

ANALYSIS OF PROCEDURES AND COMPUTER TECHNIQUES

The key element in creating a permuted title index is the keyword file. This file must be capable of being sorted and must contain the applicable master title or reference code to facilitate search for the master title. The preferable method of obtaining titles is to include them in the keyword records. In this manner, titles are "carried along" as keywords are sorted. This procedure allows direct write-out of the sorted tape and obviates the need to search the master record file. This procedure was attempted in the solution of this problem and was successfully used on a test data deck consisting of sixty sets of data. However, complications arose when the full three thousand record sets were processed. The keyword tape file required six tape reels to store all keywords found plus the applicable master record. This fact rendered the solution to the problem impossible with the computer equipment at hand because the generalized sort system for the University of Kansas computer will sort only to a maximum of three reels of tape.

Alternate Strategies The need to reduce the size of the keyword file being apparent, it was decided to eliminate the master listing carried along with the keyword and serial code. This change allowed a reduction in record length from 246 words per record to 29 words per record.

This change, in reducing the keyword tape by a factor

of eight, did circumvent the physical limitation imposed on the preferred solution. But, and this is an important but, the solution became dependent on time consuming tape-search procedures.

Another alternative, which was not tried but which now appears most sensible, would be to compress the keyword file by a factor of six. This could be accomplished through the use of the PACK subprogram (page 58) which is used in the school-code determination program. By condensing the keyword file, slight modification would be required to be made to field specifications in the SORT control cards, but this would pose no problem. Once the keyword tape was sorted, write-out procedures could be executed with one small addition to the write-out program. The compressed words on the keyword tape must be de-compressed or UNPACKED in order that character by character control may be exercised in the positioning of the permuted title. The unpacking operation could be performed through the use of the subprogram UNPACK which is listed in Appendix A, page 58 .

Utilization of Computer Time Because of the need to use the tape storage media rather than internal computer memory to hold the master file, keyword file, and author file, much of the advantage gained in using a high speed computer is blunted by a repeated tape-READ and tape-WRITE procedures which are inherently slower operations than the movement of data within core memory. The program presented with

this paper essentially deals with one record at a time, and no analysis is made to determine the optimum use of core storage to speed the computer operations. The matter of computer time usage is an economic one which must be taken into consideration in weighing the cost of generating permuted title indexes versus the expected gain in research productivity.

Some methods for optimizing the use of computer time are discussed below as applied to the problem at hand. First, and most importantly, the strategy of tape-searching must be avoided if possible because each increase in file size requires greater time to locate each title record. The need to "carry along" the title as keywords are sorted is of paramount importance when using a tape-oriented system. Disk storage, with its high access speed, would lessen the dilemma if sufficient disk space were available to hold the complete files stored on tape in the tape-oriented system.

If all avenues of escape are closed and tape-search procedures remain as the only solution to the problem, much time may still be saved by incorporating a dual master file. This procedure involves duplicate master file tapes. The program is written to search each tape on an alternating basis so that when one search is complete, and the tape is rewinding, the program may proceed to search the alternate tape without waiting for the completion of rewind procedures.

Secondly, the keyword file itself may be reduced in size by increasing the size of the discard dictionary.

This solution will reduce sort and write-out time, but it will require longer running time in loading the tapes.

The fifteen common words, in order of occurrence, which are listed below account for 30% of all words in titles.[12]

1. of
2. the
3. and
4. in
5. on
6. by
7. a
8. with
9. for
10. from
11. to
12. some
13. as
14. at
15. an

These fifteen words are the work horses of the discard dictionary. The incorporation of additional discard words in the dictionary provides for neater output listing, but the increase requires much additional computer running time. On the test data, increasing the discard dictionary from fifteen to thirty words caused running time to increase in approximately the same ratio (1-2).

Thus, in designing an optimum system, some balance must be reached between increases in discard dictionary size and elimination of low-value words in the permuted index. The list of discard words for this problem is shown in Appendix A, page 60.

The third area of discussion pertains to READ-WRITE operations. At the completion of program de-bugging, remaining unused core space should be divided into two holding arrays. This would allow READ-in of more than one data set per READ command, and more than one WRITE-output per WRITE command. By reducing the number of referrals to peripheral equipment from the main computer, additional

time would be conserved.

Interpretation of Output Appendix C, fold-out page 62, shows samples of three elements of the permuted title index. On the left is the school code dictionary. The center section shows the permuted index, and the right hand section, the master bibliographic listing. The school dictionary is in numerical order; the permuted index is in alphabetical order by keyword; and the master listing is in order of serial code number. To obtain the complete title which pertains to a keyword of interest to the researcher, the serial code serves as reference to enter the master listing. The school of publication may be read directly using the school code number which is part of the serial-year-school code number.

Chapter V

CONCLUSION

Two questions were posed at the outset of this problem:

1- Did a feasible solution to the problem of permuted title indexing exist when a fixed-word-length computer was used rather than the apparently more logical variable-word-length computer?

2- Given that a fixed-word-length computer would be used in the solution of the problem in permuted title indexing, did a feasible solution exist with the use of the engineering-oriented computer language FORTRAN?

The answers to these two questions are in the affirmative, but with some qualifications.

Summation of Findings

1- Permuted title index problems may be solved using fixed-word-length computers.

2- FORTRAN computer language is adequate to perform the tasks involved in creating a permuted index. Variable format capability, while not a mandatory requirement, would have simplified the WRITE portions of the overall program.

3- Discard dictionary size should be kept as small as practicable.

4- Keyword files which will be sorted by keyword should contain full title if at all possible. The procedure of tape-searching should be avoided when other solutions are available.

Projections of the Future This project involved the classic problems of creating a permuted title index. As machine capabilities increase, as programming languages incorporate new concepts applicable to information retrieval, and as the need for more detailed research tools become apparent, it will be necessary to improve the permuted index from a simple alphabetic listing to a more detailed listing involving heirarchies of information. This will require establishment of new and different criteria for sorting.

This type of information retrieval tool has some of its most promising applications in the field of engineering, both practical and theoretical.

The question remains whether engineers will provide their own research tools or wait for the librarians to do it for them.

Food for Thought "When computers have been programmed to nose out more new mathematical proofs, when one-pack patiences have been mechanically played to stimulate the nature of a control system, when a computer is used, but reliably (as it will be), to paint pictures and write poems, and equipped with a machine-sized thesaurus to translate and therefore comparatively to identify differences of

context in metaphysical and theological statements in different languages, when all this happens, will the programmer, the analytical wielder of this new mathematical paintbrush, be an artist, or will he be a scientist?" [13]

REFERENCES

1. 7040-7044 Fortran Programmer's Guide, IBM Operating System Manual No. C28-6329-1.
2. Macro Assembly Program (MAP), IBM Operating System Manual No. C28-6335-2.
3. Howerton, Paul W., Information Handling, 1963.
4. Luhn, Hans Peter, Keyword-in-Context for Technical Literature (KWIC Index), 1959.
5. Chevron KWIC Index, June, 1965.
6. Journal of the Association for Computing Machinery, October, 1963.
7. Kansas Slavic Index, 1963.
8. Fosket, D.J., "Freeing the Mind," London Times Literary Supplement, April 27, 1962, page 10.
9. Luhn, Hans Peter, "Automated Intelligence Systems," Information Retrieval Management, 1962, page 97.
10. "Goodyear Automates Fact Finding," Rubber World, Volume 146 #4, July, 1962, as reprinted in Readings in Information Retrieval, 1964.
11. 7040-7044 Generalized Sorting System, IBM Operating System Manual No. C28-6337-3.
12. Keyword-in-Context (KWIC) Indexing Program for the IBM 1401 Data Processing System, Application Program Bulletin No. H20-0348.
13. Masterson, Margaret, "The Intellect's New Eye," London Times Literary Supplement, April 27, 1962.

BIBLIOGRAPHY

1. The Association for Computing Machinery, Journal of the Association for Computing Machinery, New York, New York, October, 1963.
2. Bell, D.A., Information Theory and Engineering Applications, London: Pitman Press, 1962.
3. Chevron Oil Company, Chevron KWIC Index, June, 1965.
4. Dun and Bradstreet, Dun's Review, New York, New York, September, 1965.
5. Howerton, Paul W., Information Handling, London: Spartan Books, 1963.
6. IBM Corporation, 7040-7044 Fortran Programmer's Guide, IBM Operating System Manual No. C28-6329-1, New York, New York.
7. IBM Corporation, 7040-7044 Generalized Sorting System, IBM Operating System Manual No. C28-6337-3, New York, New York.
8. IBM Corporation, Keyword-in-Context Indexing, IBM Manual E20-8091, New York, New York.
9. IBM Corporation, Keyword-in-Context (KWIC) Indexing Program for the IBM 1401 Data Processing System, Application Program Bulletin H20-0348, New York, New York.
10. IBM Corporation, Macro Assembly Program (MAP), IBM Operating System Manual No. C28-6335-2, New York, New York.

11. Licklider, J.C., Libraries of the Future, Cambridge, Massachusetts: MIT Press, 1965.
12. London Times Press, London Times Literary Supplement, London, April, 1962.
13. Luhn, Hans Peter, "Automated Intelligence Systems," Information Retrieval Management, American Data Processing, 1962.
14. Luhn, Hans Peter, Keyword-in-Context Index for Technical Literature (KWIC Index), Yorktown Heights, New York: IBM, 1959.
15. Perry, J.W., A. Kent, and M.M. Berry, Machine Literature Searching, Cleveland, Ohio: Science Publishers Inc., 1956.
16. Sharp, Harold S., Readings in Information Retrieval, New York: Scarecrow Press, 1964.
17. The University of Kansas Libraries, Kansas Slavic Index, Lawrence, Kansas, 1963.
18. Vicery, B.C., On Retrieval System Theory, London: Butterworths, 1961.
19. Western Reserve University, Information Retrieval in Action, University Heights, Ohio, 1963.

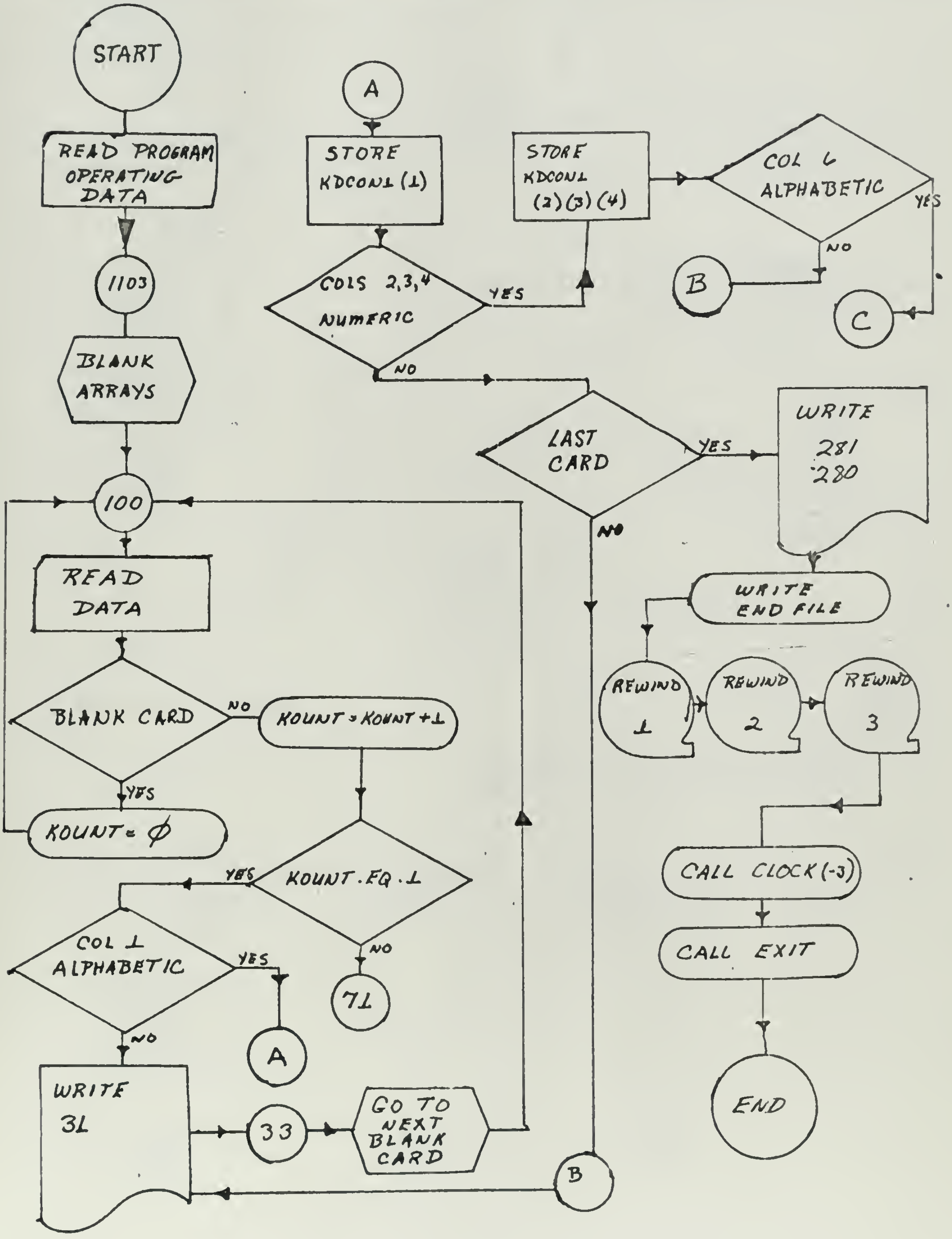
APPENDIX A

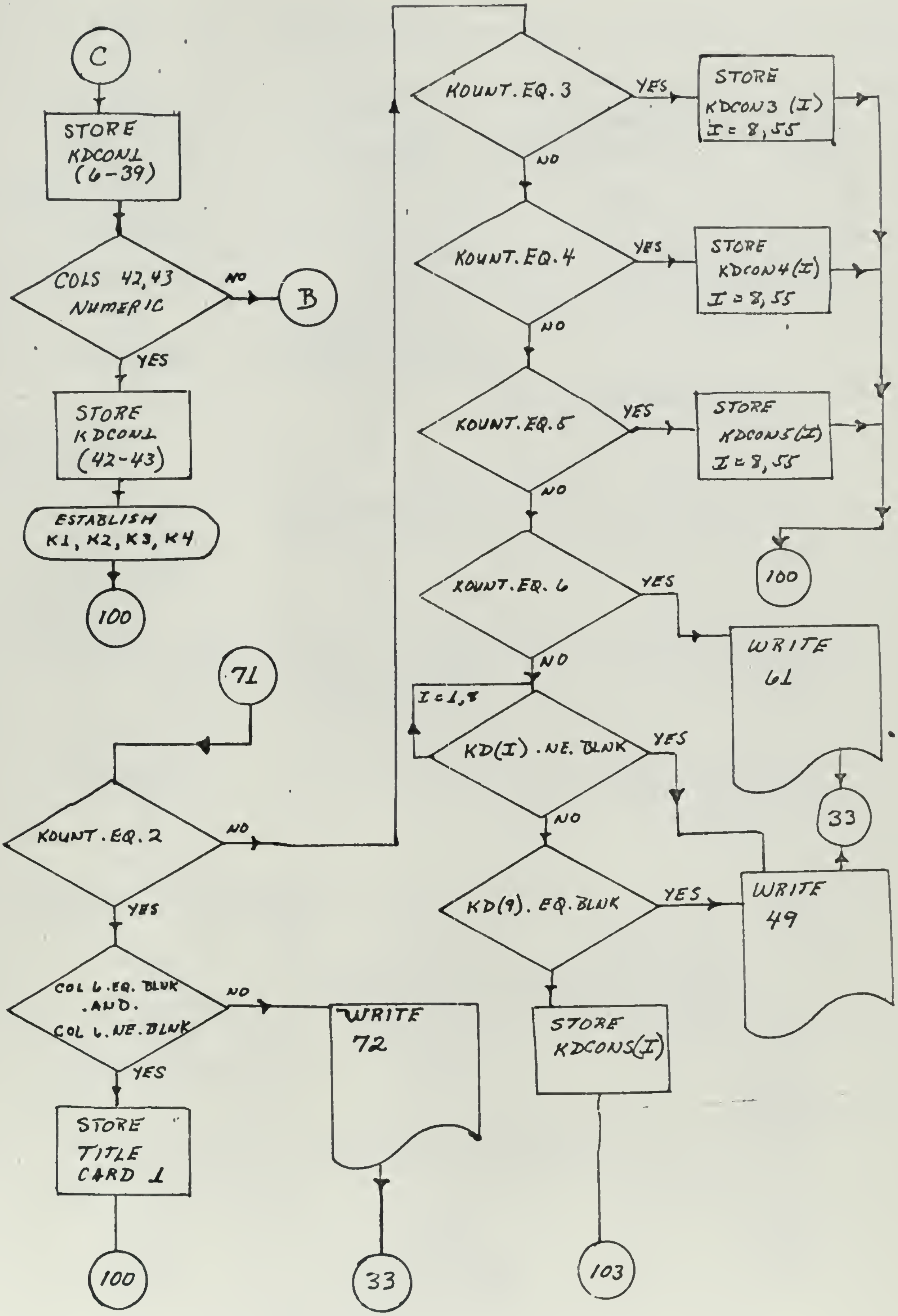
FORTRAN NOTATION

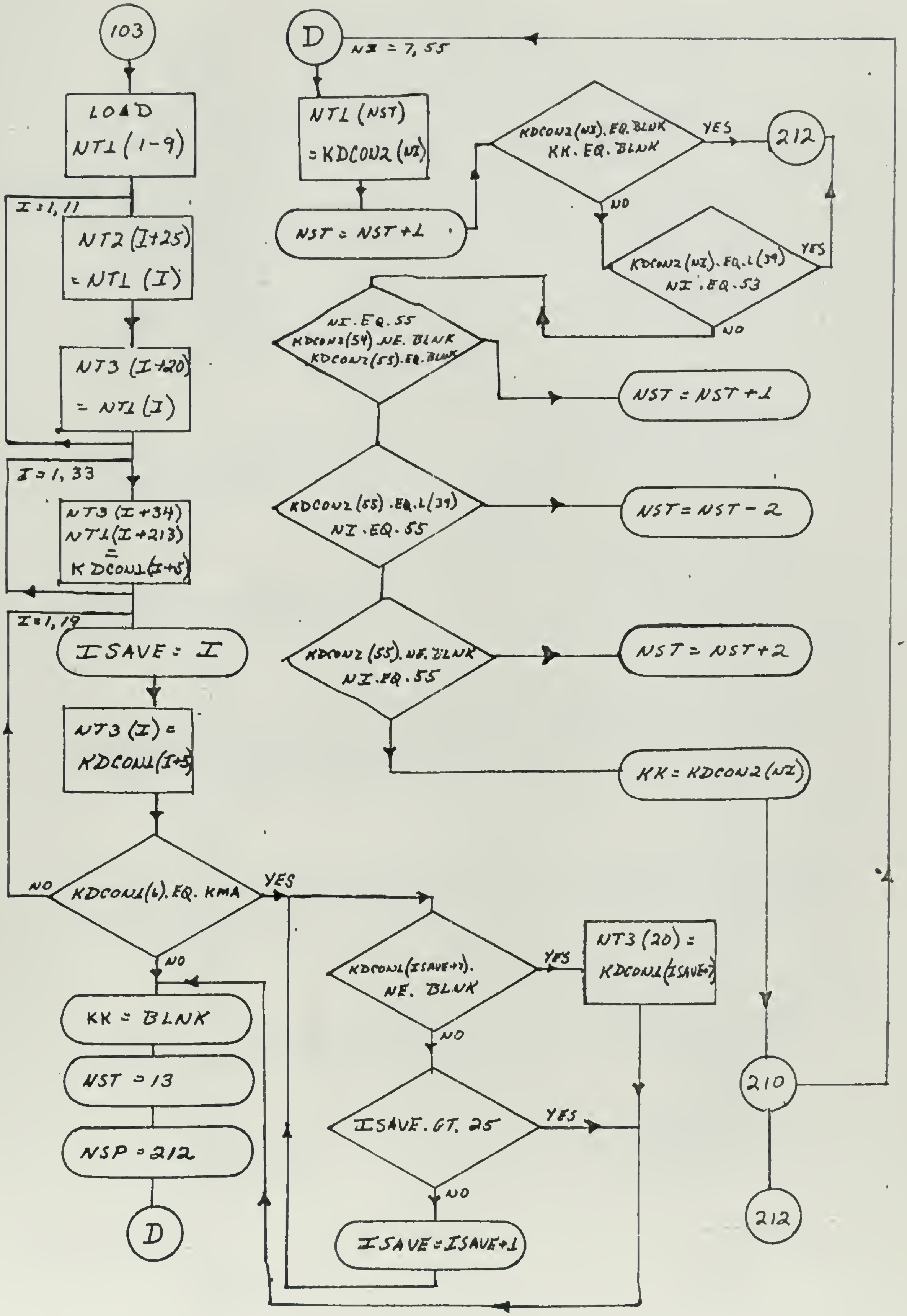
KD(I)	DATA CARD- (I) CONTROLS COLUMN IDENTIFICATION
KDCON1(I)	AUTHOR CARD DATA
KDCON2(I)	TITLE CARD DATA
KDCON3(I)	TITLE CARD DATA (CONT)
KDCON4(I)	TITLE CARD DATA (CONT)
KDCON5(I)	TITLE CARD DATA (CONT)
KDCONS(I)	SCHOOL CARD DATA
SKL(I,J)	SCHOOL DICTIONARY (I) CONTROLS SCHOOL (J) CONTROLS WORDS IN SCHOOL NAME
L(I)	AN ARRAY CONTAINING ALL KEYPUNCH REPRESENTATIONS IN ALPHANUMERIC MODE
TMPKW(I)	TEMPORARY KEYWORD USED IN TESTING PROCESS
DCD(I,J)	DISCARD DICTIONARY (I) CONTROLS WORDS (J) CONTROLS LETTERS
KW(I)	KEYWORD AS DETERMINED BY SUBROUTINE KICK
NT1(I)	RECORD AS COMPILED IN FINAL FORM FOR STORAGE ON MASTER TAPE
NT2(I)	KEYWORD RECORD AS COMPILED IN FINAL FORM FOR STORAGE ON KEYWORD TAPE
NT3(I)	AUTHOR RECORD AS COMPILED IN FINAL FORM FOR STORAGE ON AUTHOR TAPE
NTEST(I)	HOLDING ARRAY USED IN DETERMINATION OF WORDS
KOUNT	CARD COUNT INDICATOR TO DETERMINE WHICH CARD IN SET IS BEING OPERATED UPON
NTAPE1	TAPE NAME FOR MASTER BIBLIOGRAPHIC LISTING
NTAPE2	TAPE NAME FOR KEYWORD TAPE
NTAPE3	TAPE NAME FOR AUTHOR TAPE
NC1(I,J)	HOLDING ARRAY FOR KEYWORDS AND LOCATION USED TO FACILITATE LISTING OF KEYWORDS
NRITE(I)	HOLDING ARRAY USED FOR POSITIONING TITLE IN ORDER THAT KEYWORD WILL BE POSITIONED IN PROPER COLUMN

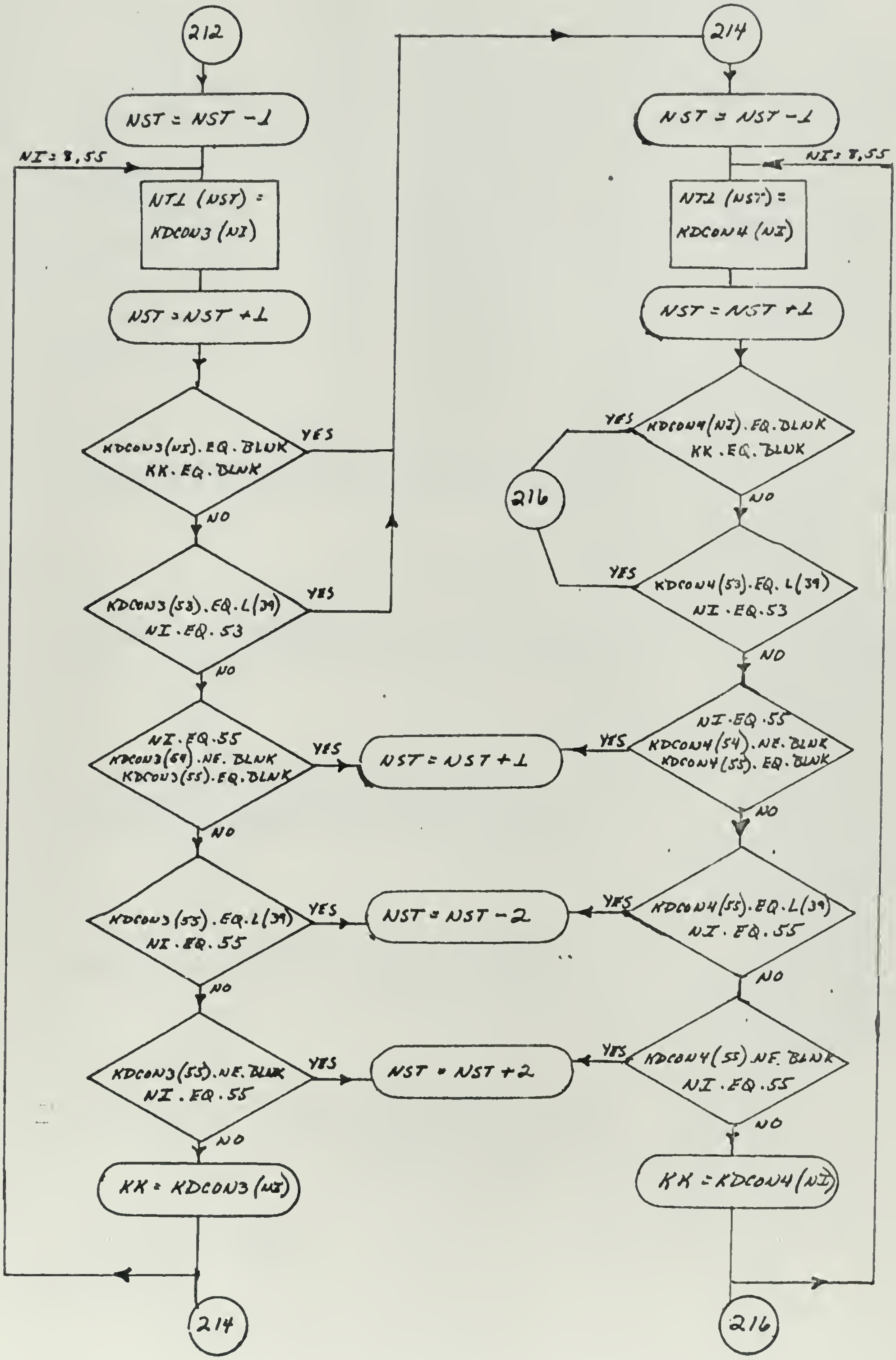
NST	MAINLINE COUNTER TO SPECIFY WHICH COLUMN OF NT1 BETWEEN COLS 13 AND 212 IS BEING OPERATED UPON
LOC	MAINLINE COUNTER WHICH DETERMINES RELATIVE LOCATION BETWEEN 1 AND 200 OF FIRST LETTER OF KEYWORD
LLOC	WRITE-OUT PROGRAM FOR KEYWORD TAPE - RELATIVE LOCATION OF FIRST LETTER OF KEYWORD IN NRITE (1 THRU 600)
L1	LOWER LIMIT OF NRITE(I) WHICH IS TO BE WRITTEN OUT
L2	UPPER LIMIT OF NRITE(I) WHICH IS TO BE WRITTEN OUT

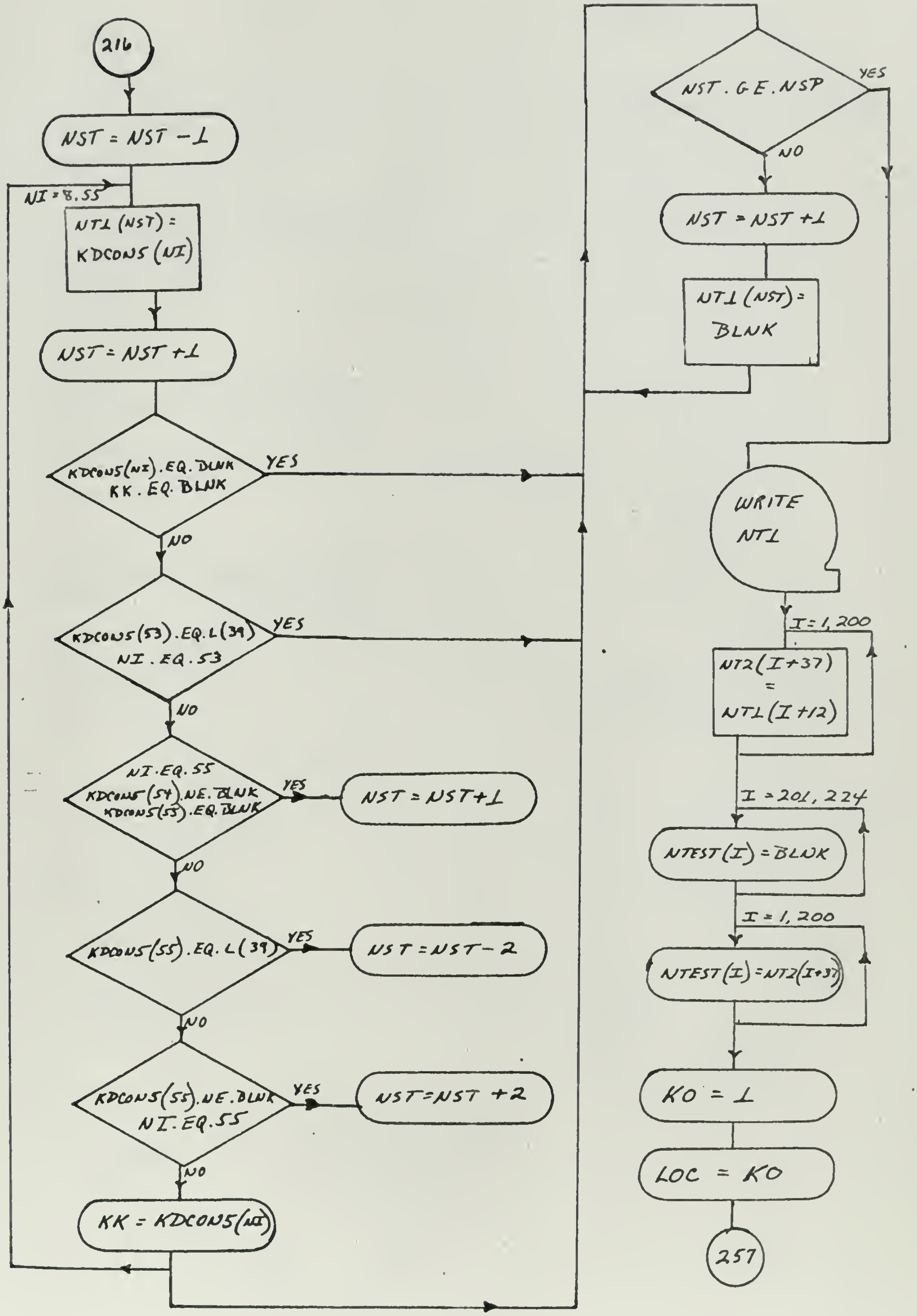
FLOW CHART FOR MAINLINE PROGRAM TO LOAD TAPES

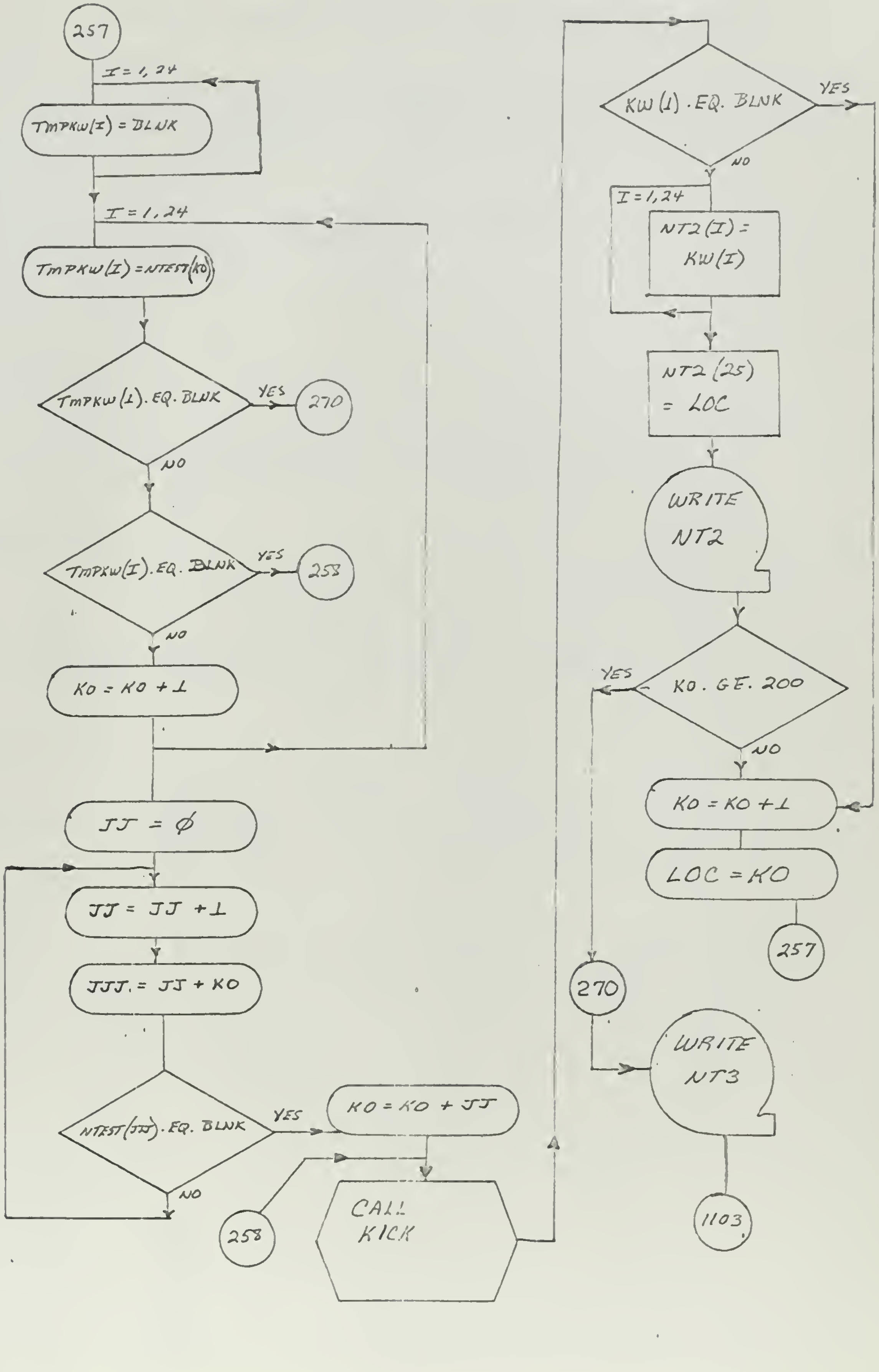



C
STORE KDCONL (6-39)
COLS 42,43 NUMERIC
NO
B
YES
STORE KDCONL (42-43)
ESTABLISH K1, K2, K3, K4
100
71
KOUNT.EQ.2
NO
YES
COL 6.EQ.BLNK .AND. COL 6.NE.BLNK
NO
WRITE 72
33
YES
STORE TITLE CARD 1
100
KOUNT.EQ.3
YES
STORE KDCON3 (I) I = 8,55
NO
KOUNT.EQ.4
YES
STORE KDCON4(I) I = 8,55
NO
KOUNT.EQ.5
YES
STORE KDCON5(I) I = 8,55
NO
100
KOUNT.EQ.6
YES
WRITE 61
33
NO
I = 1,8
KD(I).NE.BLNK
YES
NO
KD(9).EQ.BLNK
YES
WRITE 49
STORE KDCONS(I)
103


103
LOAD NT1 (1-9)
I = 1, 11
NT2 (I+25) = NT1 (I)
NT3 (I+20) = NT1 (I)
I = 1, 33
NT3 (I+34) NT1(I+213) = KDCON1(I+5)
I = 1, 19
ISAVE = I
NT3 (I) = KDCON1(I+5)
KDCON1(6).EQ. KMA
NO
YES
NO
KK = BLNK
NST = 13
NSP = 212
D
D
NI = 7, 55
NT1 (NST) = KDCON2 (NI)
NST = NST+1
KDCON2(NI).EQ.BLNK KK.EQ.BLNK
YES
212
NO
KDCON2(NI).EQ.1(39) NI.EQ.53
YES
NO
NI.EQ.55 KDCON2(54).NE.BLNK KDCON2(55).EQ.BLNK
NST = NST+1
KDCON2(55).EQ.1(39) NI.EQ.55
NST = NST-2
KDCON2(55).NE.BLNK NI.EQ.55
NST = NST+2
KK = KDCON2(NI)
KDCON1(ISAVE+7). NE. BLNK
YES
NT3 (20) = KDCON1(ISAVE+7)
NO
ISAVE.GT. 25
YES
NO
ISAVE = ISAVE+1
210
212


212
NST = NST - 1
NI = 8,55
NT1 (NST) = KDCON3 (NI)
NST = NST + 1
KDCON3(NI).EQ.BLNK
KK.EQ.BLNK
YES
NO
KDCON3(53).EQ.L(39)
NI.EQ.53
YES
NO
NI.EQ.55
KDCON3(54).NE.BLNK
KDCON3(55).EQ.BLNK
YES
NST = NST + 1
NO
KDCON3(55).EQ.L(39)
NI.EQ.55
YES
NST = NST - 2
NO
KDCON3(55).NE.BLNK
NI.EQ.55
YES
NST = NST + 2
NO
KK = KDCON3(NI)
214
214
NST = NST - 1
NI = 8,55
NT1 (NST) = KDCON4 (NI)
NST = NST + 1
YES
KDCON4(NI).EQ.BLNK
KK.EQ.BLNK
216
NO
YES
KDCON4(53).EQ.L(39)
NI.EQ.53
NO
NI.EQ.55
YES
KDCON4(54).NE.BLNK
KDCON4(55).EQ.BLNK
NO
YES
KDCON4(55).EQ.L(39)
NI.EQ.55
NO
YES
KDCON4(55).NE.BLNK
NI.EQ.55
NO
KK = KDCON4(NI)
216


216
NST = NST − 1
NI = 8, 55
NT1 (NST) = KDCONS (NI)
NST = NST + 1
KDCONS(NI).EQ.BLNK
KK.EQ.BLNK
YES
NO
KDCONS(53).EQ.L(39)
NI.EQ.53
YES
NO
NI.EQ.55
KDCONS(54).NE.BLNK
KDCONS(55).EQ.BLNK
YES
NST = NST+1
NO
KDCONS(55).EQ.L(39)
YES
NST = NST − 2
NO
KDCONS(55).NE.BLNK
NI.EQ.55
YES
NST = NST + 2
NO
KK = KDCONS(NI)
NST.GE.NSP
YES
NO
NST = NST + 1
NT1 (NST) = BLNK
WRITE NT1
I = 1, 200
NT2(I+37) = NT1(I+12)
I = 201, 224
NTEST(I) = BLNK
I = 1, 200
NTEST(I) = NT2(I+37)
KO = 1
LOC = KO
257


257
I = 1, 24
TMPKW(I) = BLNK
I = 1, 24
TMPKW(I) = NTEST(KO)
TMPKW(1).EQ.BLNK
YES
270
NO
TMPKW(I).EQ.BLNK
YES
258
NO
KO = KO + 1
JJ = 0
JJ = JJ + 1
JJJ = JJ + KO
NTEST(JJJ).EQ.BLNK
YES
NO
KO = KO + JJ
258
CALL KICK
KW(1).EQ.BLNK
YES
NO
I = 1, 24
NT2(I) = KW(I)
NT2(25) = LOC
WRITE NT2
KO.GE.200
YES
NO
KO = KO + 1
LOC = KO
257
270
WRITE NT3
1103

```
    1 FORMAT  ( 80A1)
C ------------------------------------------------------------------------------
      DO 2  I = 1,80
    2 IF (KD(I) .NE. BLNK )   GO TO 4
    3 KOUNT = 0
      GO TO 100
    4 KOUNT = KOUNT + 1
      IF (KOUNT . NE.1 )  GO TO 71
      IF(NBRT(KD(1)))     GO TO 31
      KDCON1(1)  = KD(1)
      DO 5 I=2,4
      IF(.NOT. NBRT(KD(I)))     GO TO 35
    5 KDCON1(I)  = KD(I)
      IF(NBRT(KD(6)))      GO TO 31
      DO 6 I = 6,39
      KDCON1(I)  = KD(I)
    6 CONTINUE
      DO 7 I = 42,43
      IF (.NOT.NBRT(KD(I)))     GO TO 31
    7 KDCON1(I)  = KD(I)
C    CREATION OF TEMPORARY REFERENCE NUMBER
      K1 = KD(1)
      K2 = KD(2)
      K3 = KD(3)
      K4 = KD(4)
      GO TO 100
C ------------------------------------------------------------------------------
C    ROUTINE FOR SECOND CARD IN SET
   71 IF (KOUNT.NE.2)  GO TO 41
      IF(KD(6).EQ.BLNK.AND.KD(7).NE.BLNK )  GO TO 73
      WRITE (6,72) K1,K2,K3,K4
   72 FORMAT (10X,34HERROR IN TITLE CARD - LAST SERIAL , 4A1)
      GO TO 33
   73 CONTINUE
      DO 74 I = 7,55
   74 KDCON2(I) = KD(I)
      GO TO 100
C ------------------------------------------------------------------------------
C   ROUTINE FOR CARDS 3,4,5,6
   41 CONTINUE
   44 IF((KD(7).EQ.BLNK).AND.(KD(8).NE.BLNK).AND.(KOUNT.EQ.3))GO TO 42
      IF((KD(7).EQ.BLNK).AND.(KD(8).NE.BLNK).AND.(KOUNT.EQ.4))GO TO 52
      IF((KD(7).EQ.BLNK).AND.(KD(8).NE.BLNK).AND.(KOUNT.EQ.5))GO TO 55
      IF (KOUNT.GT.6)  GO TO 58
   47 DO 45 I = 1,8
   45 IF(KD(I).NE.BLNK)  GO TO 48
      IF(KD(9).EQ.BLNK)  GO TO 48
      DO 46 I = 9,55
   46 KDCONS(I) = KD(I)
      GO TO 103
   42 DO 43 I = 8,55
   43 KDCON3(I) = KD(I)
      GO TO 100
C ------
   48 WRITE (6,49) K1,K2,K3,K4
```

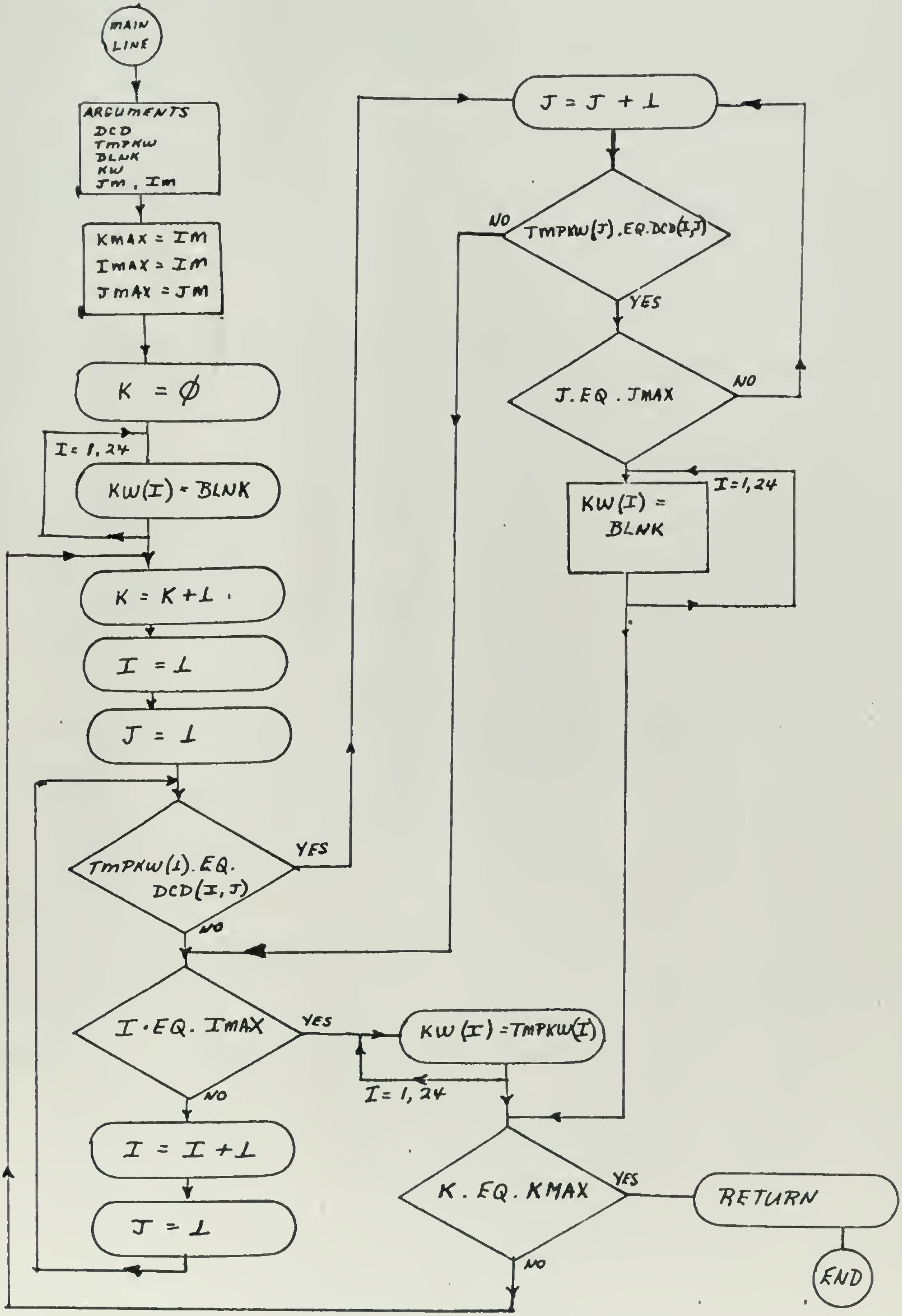
```
   49 FORMAT (10X,50HERROR IN TITLE CARD OR SCHOOL CARD - LAST SERIAL =
     1, 4A1)
C ------
      GO TO 33
   52 DO53 I = 8,55
   53 KDCON4(I) = KD(I)
      GO TO 100
   55 DO 56 I = 8,55
   56 KDCON5(I) = KD(I)
      GO TO 100
   58 WRITE (6,61) K1,K2,K3,K4
   61 FORMAT(10X,37HCARD COUNT EXCEEDS 6 - LAST SERIAL = , 4A1)
      GO TO 33
   59 CONTINUE
C    NOW WE LOAD ALL ARRAYS IN CONDENSED FORM
      GO TO 103
C ---------------------------------------------------------------------------
C    ERROR STATEMENT FOR AUTHOR CARD
   31 WRITE (6,32) KD
   32 FORMAT ( 10X,17HAUTHOR CARD ERROR, 10X, 80A1)
   33 READ (5,1) KD
      DO 34  I = 1,80
   34 IF ( KD(I).NE.BLNK)  GO TO 33
      KOUNT = 0
      GO TO 100
C ---------------------------------------------------------------------------
C   TEST FOR LAST CARD
   35 DO 36 I = 11,80
   36 IF (KD(I) .NE.L(9)) GO TO 31
C    END OF FILE SIGN -- 24 LETTER Z=S
      DO 280 I= 1,24
      NT1(I) = L(36)
      NT2(I) = L(36)
  280 NT3(I) = L(36)
      WRITE (NTAPE1) (NT1(J), J= 1,246)
      WRITE (NTAPE2)  (NT2(J), J=1,29)
C     WRITE (NTAPE3)    (NT3(J), J=1,68)
      GO TO 1000
C ---------------------------------------------------------------------------
C    PROGRAM TO LOAD TAPES 1,2,+3
  103 CONTINUE
      DO 201 I=1,246
      NT1(I) =  BLNK
  201 NT2(I) = BLNK
      DO 202 I= 1,48
  202 NT3(I) = BLNK
      KSCHL = KSKOL(KDCONS)
      J1 = KDCON1( 1)
      J2 = KDCON1( 2)
      J3 = KDCON1( 3)
      J4 = KDCON1( 4)
      J6 = KDCON1(42)
      J7 = KDCON1(43)
      NT1(1)  = J1
      NT1(2)  = J2
```

```
      NT1(3)  = J3
      NT1(4)  = J4
      NT1(6)  = J6
      NT1(7)  = J7
      NT1(9)  = KSCHL
      DO 203  I=1,11
      NT2(I+25)  = NT1(I)
  203 NT3(I+20)  = NT1(I)
      DO 204 I = 1,33
      NT3(I+34)  = KDCON1(I+5)
  204 NT1(I+213) = KDCON1(I+5)
C  LOAD AUTHOR NAME AND FIRST LETTER FOR SORTING
      DO 230 I=1,19
      ISAVE = I
      NT3(I) = KDCON1(I+5)
      IF  (KDCON1(I+6).EQ.KMA)   GO TO 231
  230 CONTINUE
      GO TO 239
  232 CONTINUE
  231 IF  (KDCON1(ISAVE+7).NE.BLNK)   GO TO 238
      IF (ISAVE.GT.25)  GO TO 239
      ISAVE = ISAVE +1
      GO TO 232
  238 NT3(20) = KDCON1(ISAVE+7)
  239 CONTINUE
C   -----
C  NOW SEARCH FOR KEYWORD AND KW LOCATION
C ------
      KK = BLNK
      NST = 13
      NSP = 212
      DO 210 NI= 7,55
      NT1(NST) = KDCON2(NI)
      NST = NST+1
      IF ((KDCON2(NI).EQ.BLNK).AND.(KK.EQ.BLNK))  GO TO 212
      IF ((KDCON2(53).EQ.L(39)).AND.(NI.EQ.53))  GO TO 212
      IF((KDCON2(54).NE.BLNK).AND.(KDCON2(55).EQ.BLNK).AND.(NI.EQ.55))
     1 NST = NST +1
      IF ((KDCON2(55).EQ. L(39)) .AND.(NI.EQ.55))   NST = NST -2
      IF ((KDCON2(55).NE.BLNK) .AND.(NI.EQ.55))  NST = NST +2
      KK = KDCON2(NI)
  210 CONTINUE
  212 CONTINUE
      NST = NST - 1
      DO 213 NI = 8,55
      NT1(NST) = KDCON3(NI)
      NST = NST +1
      IF ((KDCON3(NI).EQ.BLNK).AND.(KK.EQ.BLNK))  GO TO 214
      IF  ((KDCON3(53).EQ.L(39)).AND.(NI.EQ.53))  GO TO 214
      IF ((KDCON3(54).NE.BLNK).AND.(KDCON3(55).EQ.BLNK).AND.(NI.EQ.55)
     1   NST = NST +1
      IF  ((KDCON3(55).EQ. L(39)) .AND.(NI.EQ.55))   NST = NST -2
      IF  ((KDCON3(55).NE.BLNK) .AND.(NI.EQ.55))  NST = NST +2
      KK = KDCON3(NI)
  213 CONTINUE
```

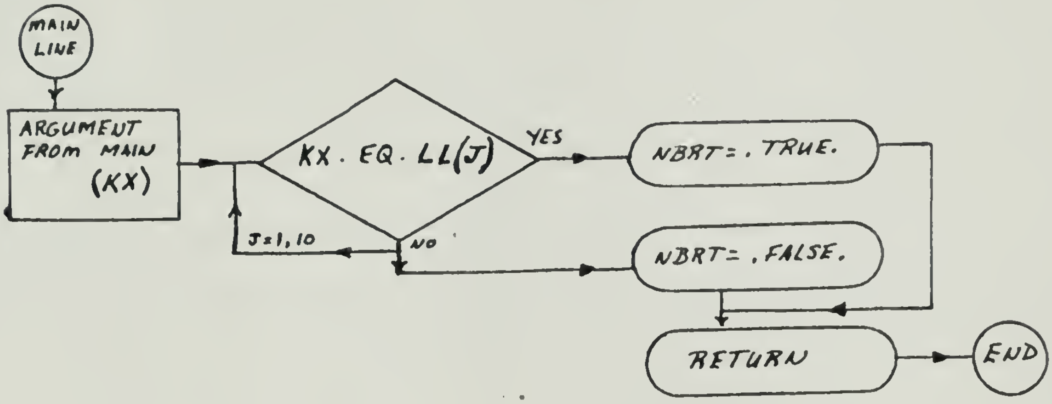
```
  214 CONTINUE
      NST = NST - 1
      DO 215  NI = 8,55
      NT1(NST) = KDCON4(NI)
      NST = NST +1
      IF ((KDCON4(NI).EQ.BLNK).AND.(KK.EQ.BLNK))    GO TO 216
      IF  ((KDCON4(53).EQ.L(39)).AND.(NI.EQ.53))  GO TO 216
      IF ((KDCON4(54).NE.BLNK).AND.(KDCON4(55).EQ.BLNK).AND.(NI.EQ.55))
     1   NST = NST +1
      IF  ((KDCON4(55).EQ. L(39)) .AND.(NI.EQ.55))    NST = NST -2
      IF  ((KDCON4(55).NE.BLNK) .AND.(NI.EQ.55))  NST = NST +2
      KK = KDCON4(NI)
  215 CONTINUE
  216 CONTINUE
      NST = NST - 1
      DO 217  NI = 8,55
      NT1(NST) = KDCON5(NI)
      NST = NST +1
      IF ((KDCON5(NI).EQ.BLNK).AND.(KK.EQ.BLNK))  GO TO 218
      IF  ((KDCON5(53).EQ.L(39)).AND.(NI.EQ.53))  GO TO 218
      IF ((KDCON5(54).NE.BLNK).AND.(KDCON5(55).EQ.BLNK).AND.(NI.EQ.55))
     1   NST = NST +1
      IF  ((KDCON5(55).EQ. L(39)) .AND.(NI.EQ.55))   NST = NST -2
      IF  ((KDCON5(55).NE.BLNK) .AND.(NI.EQ.55))  NST = NST +2
      KK = KDCON5(NI)
  217 CONTINUE
  218 CONTINUE
      IF (NST.GE.NSP)  GO TO 219
      NST = NST +1
      NT1(NST) = BLNK
      GO TO 218
C ------
  219 CONTINUE
      WRITE (NTAPE1) (NT1(J), J= 1,246)
C ------
C  START ROUTINE FOR NTAPE2
      DO 220  I = 1,200
  220 NT2(I+37)  = NT1(I+12)
C   KEYWORD DETERMINATION
  250 CONTINUE
      DO 251  I=201,224
  251 NTEST(I) = BLNK
      DO 252  I= 1,200
  252 NTEST(I) = NT2(I+37)
      KO     = 1
      LCC = KO
C ------
  257 CONTINUE
      DO 253  I= 1,24
  253 TMPKW(I) = BLNK
  254 CONTINUE
      DO 255 I = 1,24
      TMPKW(I) = NTEST(KO    )
      IF (TMPKW(1).EQ.BLNK)  GO TO 270
      IF (TMPKW(I).EQ. BLNK)   GO TO 258
```

```
      KC = KC + 1
  255 CONTINUE
C   NEXT 6 STMTS ADVANCE KC TO NEXT BLNK IN EVENT KEYWORD EXCEEDS 24  LTRS
      JJ = 0
  259 JJ = JJ +1
      JJJ = KC + JJ
      IF (NTEST(JJJ    ) .EQ. BLNK)   GO TO 267
      GO TO 259
  267 KC = KC + JJ
  258 CONTINUE
C  HAVE POSSIBLE KEYWORD
      CALL KICK  (LOC, TMPKW, BLNK, KW, JMX, IMX)
C ------
      IF (KW(1).EQ.BLNK)   GO TO 260
      DO 262 I = 1,24
  262 NT2(I) = KW(I)
C   NEXT STMT STORES  RELATIVE FIRST -LETTER LOCATION OF KEYWORD
      NT2(25)  = LOC
  263 CONTINUE
C ------
  261 CONTINUE
      WRITE (NTAPE2)  (NT2(J), J=1,29)
      IF (KC    .GE.200)   GO TO 270
  260 KC     = KC     +1
      LOC = KC
      GO TO 257
C ------
  270 CONTINUE
C   START ROUTINE FOR NTAPE 3
C     WRITE (NTAPE3)    (NT3(J), J=1,68)
      GO TO 1103
C -----------------------------------------------------------------------
 1000 CONTINUE
      END FILE NTAPE1
      END FILE NTAPE2
      END FILE NTAPE3
      REWIND NTAPE1
      REWIND NTAPE2
      REWIND NTAPE3
      WRITE (6,281)
  281 FORMAT (1H1,10X,17HMAINLINE COMPLETE, / , 11X,12HTAPES LOADED,
     1 / , 11X, 13HTAPES REWOUND)
      CALL CLOCK (-3)
      CALL EXIT
      END
```

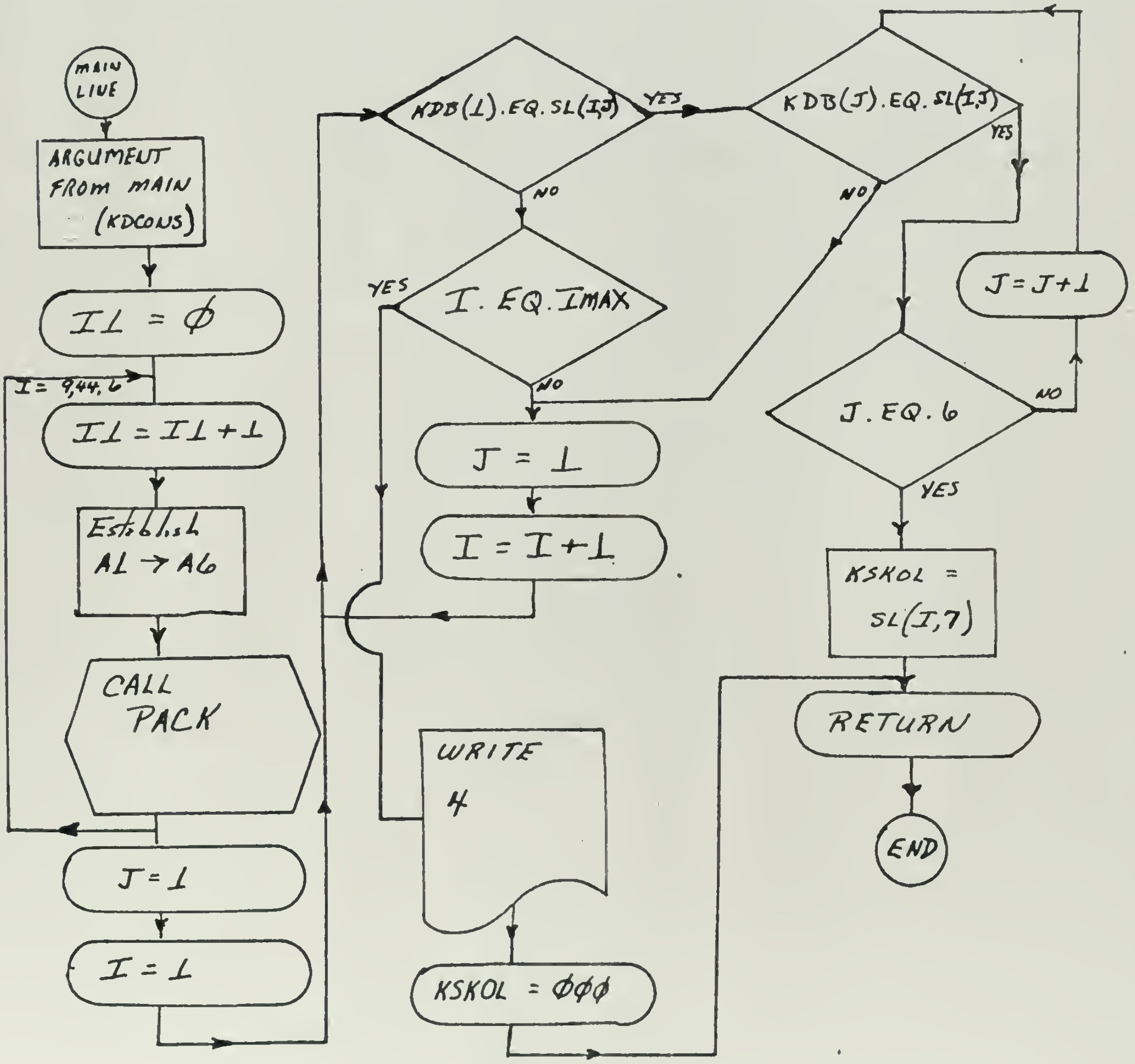
FLOW CHART FOR SUBROUTINE KICK



FLOW CHART FOR NBRT FUNCTION SUBPROGRAM



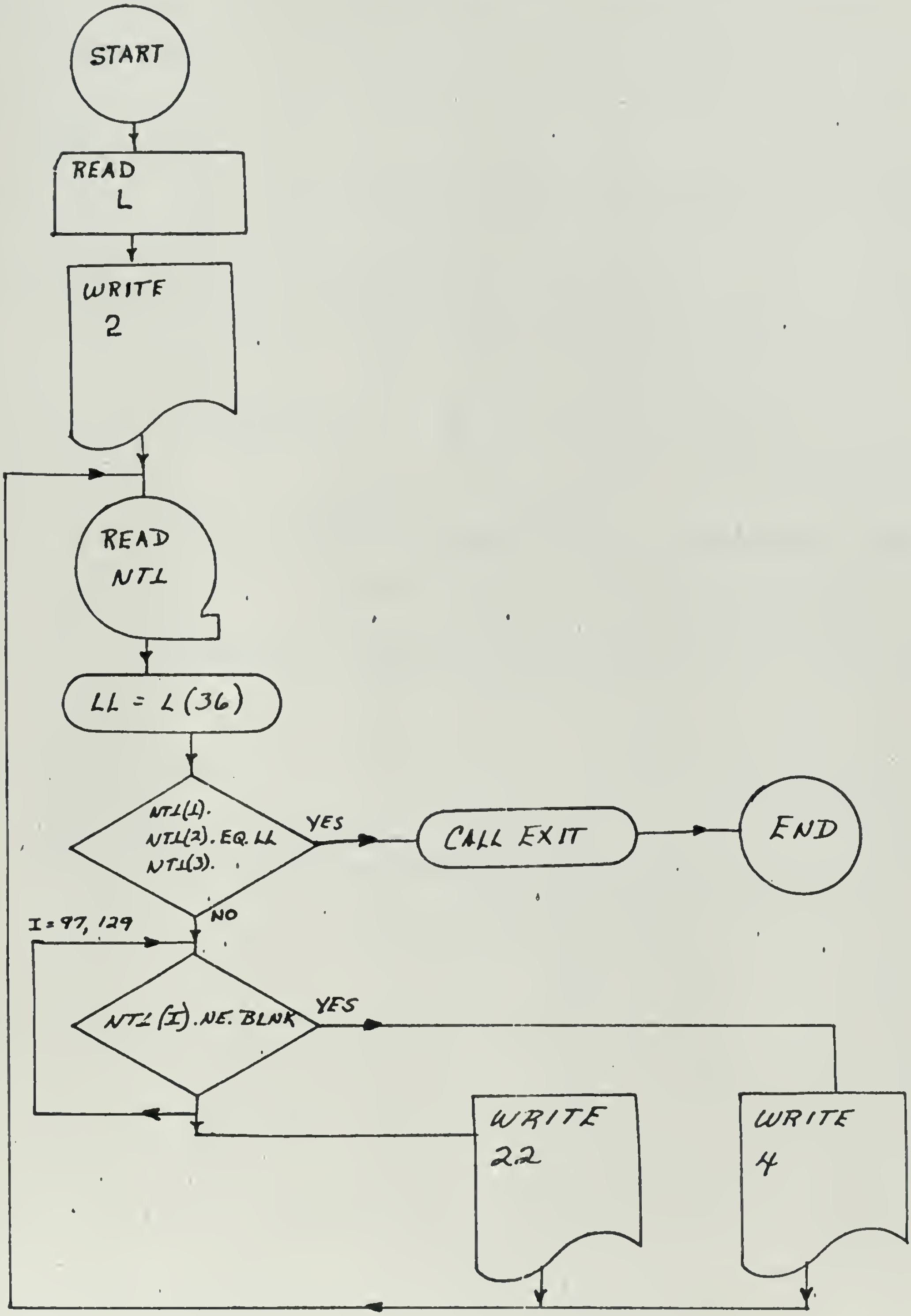
FLOW CHART FOR KSKOL FUNCTION SUBPROGRAM



```
$IBFTC NBRT     NODECK
      LOGICAL FUNCTION  NBRT(KX)
      COMMON  SL, IMAX,  LL
      DIMENSION  LL(47)
      DIMENSION  SL(150,7)
      DO 1 J = 1,10
      IF  (KX.EQ. LL(J))        GO TO 2
    1 CONTINUE
      NBRT = .FALSE.
      GO TO 3
    2 NBRT = .TRUE.
    3 CONTINUE
      RETURN
      END
```

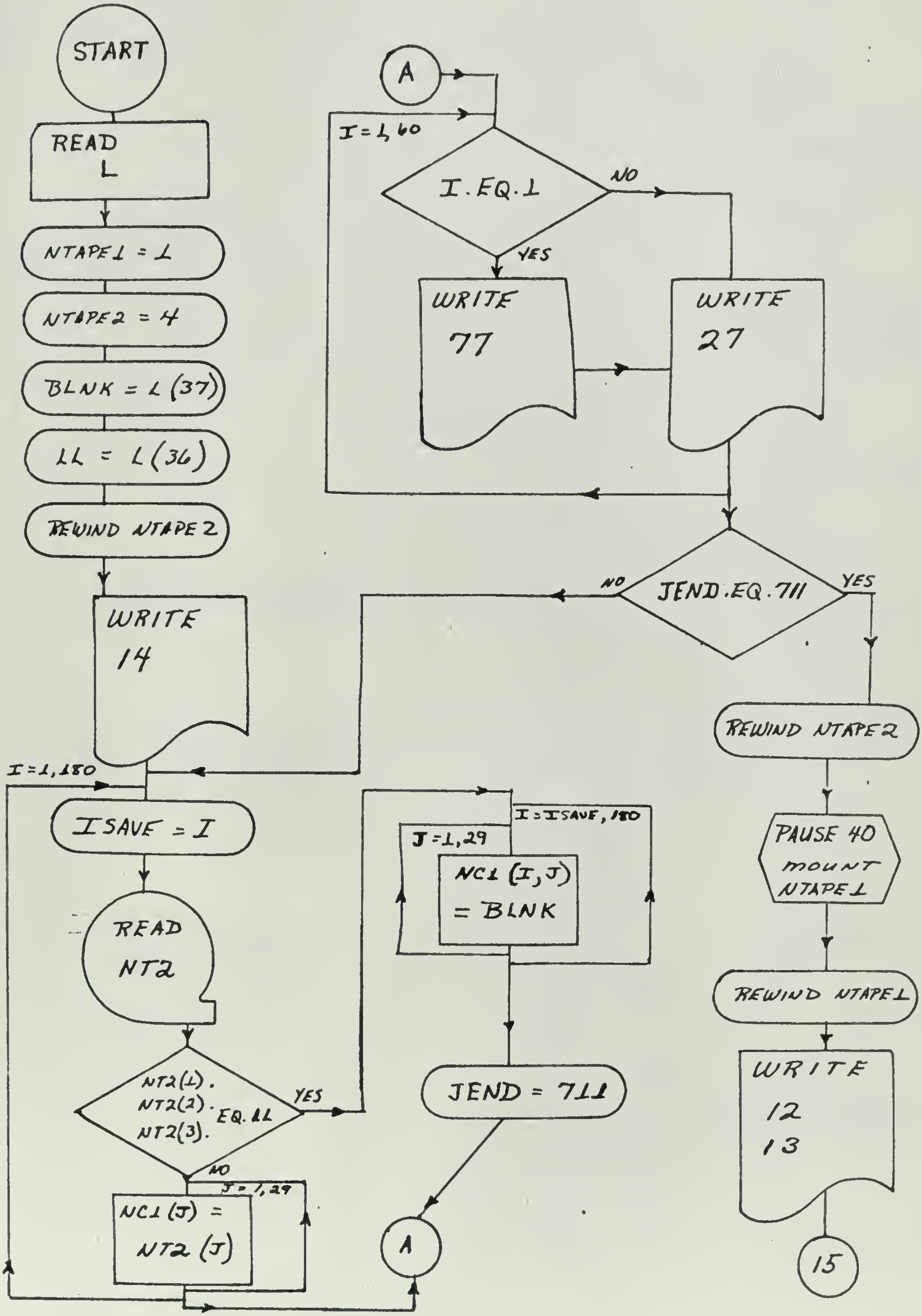
```
$IBFTC KSKOL    NODECK
      FUNCTION KSKOL  (KDCONS)
C     SUBPROGRAM TO RETURN SCHOOL CODE NUMBER
      INTEGER SL
      INTEGER A1,A2,A3,A4,A5,A6
      COMMON  SL,  IMAX,  L
      DIMENSION  SL(150,7) , KDCONS(80) , KDB(6)
      DIMENSION  L(47)
      I1 = 0
      DO 1  I2 = 9,44,6
      I1 = I1 + 1
      A1 = KDCONS(I2)
      A2 = KDCONS(I2 + 1)
      A3 = KDCONS(I2 + 2)
      A4 = KDCONS(I2 + 3)
      A5 = KDCONS(I2 + 4)
      A6 = KDCONS(I2 + 5)
      CALL PACK (KDB(I1) , A1,A2,A3,A4,A5,A6)
    1 CONTINUE
      J = 1
      I = 1
    2 CONTINUE
      IF (KDB(1).EQ.SL(I,J))    GO TO 6
      IF (I.EQ.  IMAX)   GO TO 3
    5 CONTINUE
      J = 1
      I = I + 1
      GO TO 2
    3 WRITE (6,4) (KDB(K) , K = 1,6)
    4 FORMAT (10X, 34HSCHOOL NOT LISTED OR MISSPELLED - ,  6A6 )
      KSKOL = 000
      GO TO 50
    6 CONTINUE
      IF (KDB(J) .EQ. SL(I,J))   GO TO 7
      GO TO 5
    7 CONTINUE
      IF (J.EQ.6)   GO TO 8
      J = J+1
      GO TO 6
    8 CONTINUE
C     HAVE FOUND SCHOOL IN DICTIONARY
      KSKOL = SL(I,7)
   50 CONTINUE
      RETURN
      END
```

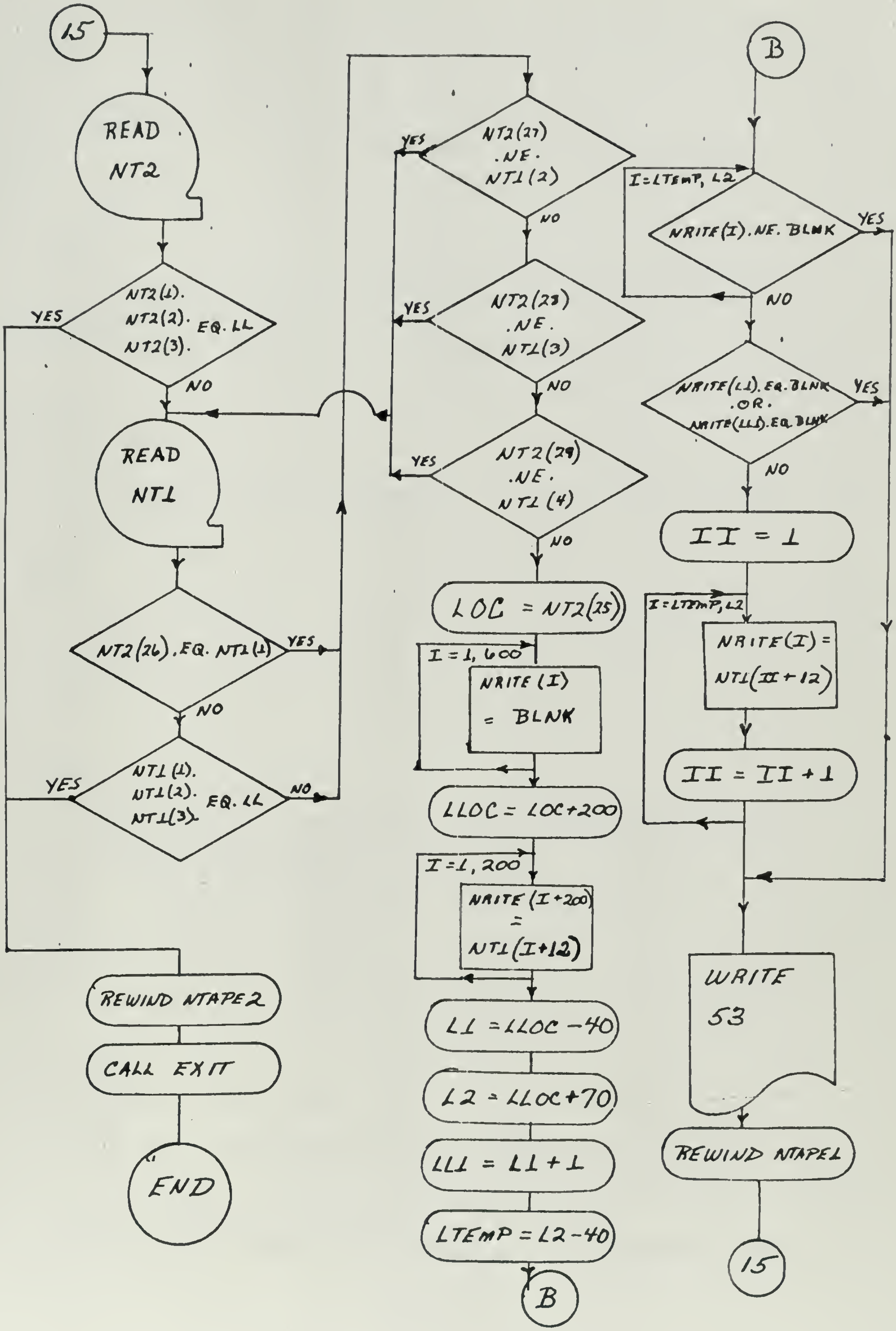
FLOW CHART FOR PROGRAM TO WRITE-OUT TAPE 1 — THE MASTER BIBLIOGRAPHY



```
$IBFTC RITE     NODECK
C    PROGRAM TO WRITE NTAPE  1
      DIMENSION  NT1(246),  NT2(246), NT3(48),    NRITE(600)
      DIMENSION L(47)
      READ (5,1)  L
    1 FORMAT (47A1)
      INTEGER BLNK
      NTAPE1 = 4
      REWIND NTAPE1
      BLNK = L(37)
      WRITE  (6,2)
    2 FORMAT (1H1, 40X,35HMASTER RECORD BIBLIOGRAPHIC LISTING,/////)
      WRITE (6,3)
    3 FORMAT (1X,4HCODE,1X,2HYR,1X,3HSCH,20X,5HTITLE, 61X, 6HAUTHOR, /)
    5 READ  (NTAPE1) (NT1(J), J= 1,246)
      LL = L(36)
      IF ((NT1(1).EQ.LL) .AND.(NT1(2).EQ.LL) .AND.( NT1(3).EQ.LL))
     1  GO TO 10
      DO 15 I = 97,129
   15 IF (NT1(I).NE.BLNK)  GO TO 20
      GO TO 21
   20 CONTINUE
      WRITE (6,4)  ( NT1(I), I = 1,246)
    4 FORMAT (1X, 8A1,A3,   120A1, / , 14X, 84A1,1H*, 33A1)
      GO TO 5
   21 CONTINUE
      WRITE (6,22)  (NT1(I),I=1,95), (NT1(J),J=214,246)
   22 FORMAT (1X,8A1,A3,  86A1, 1H*, 33A1)
      GO TO 5
   10 CONTINUE
   40 CONTINUE
      REWIND NTAPE1
      PAUSE 10
      CALL EXIT
      END
```

FLOW CHART FOR PROGRAM TO WRITE-OUT TAPE 2 AND PERMUTED-TITLE-INDEX



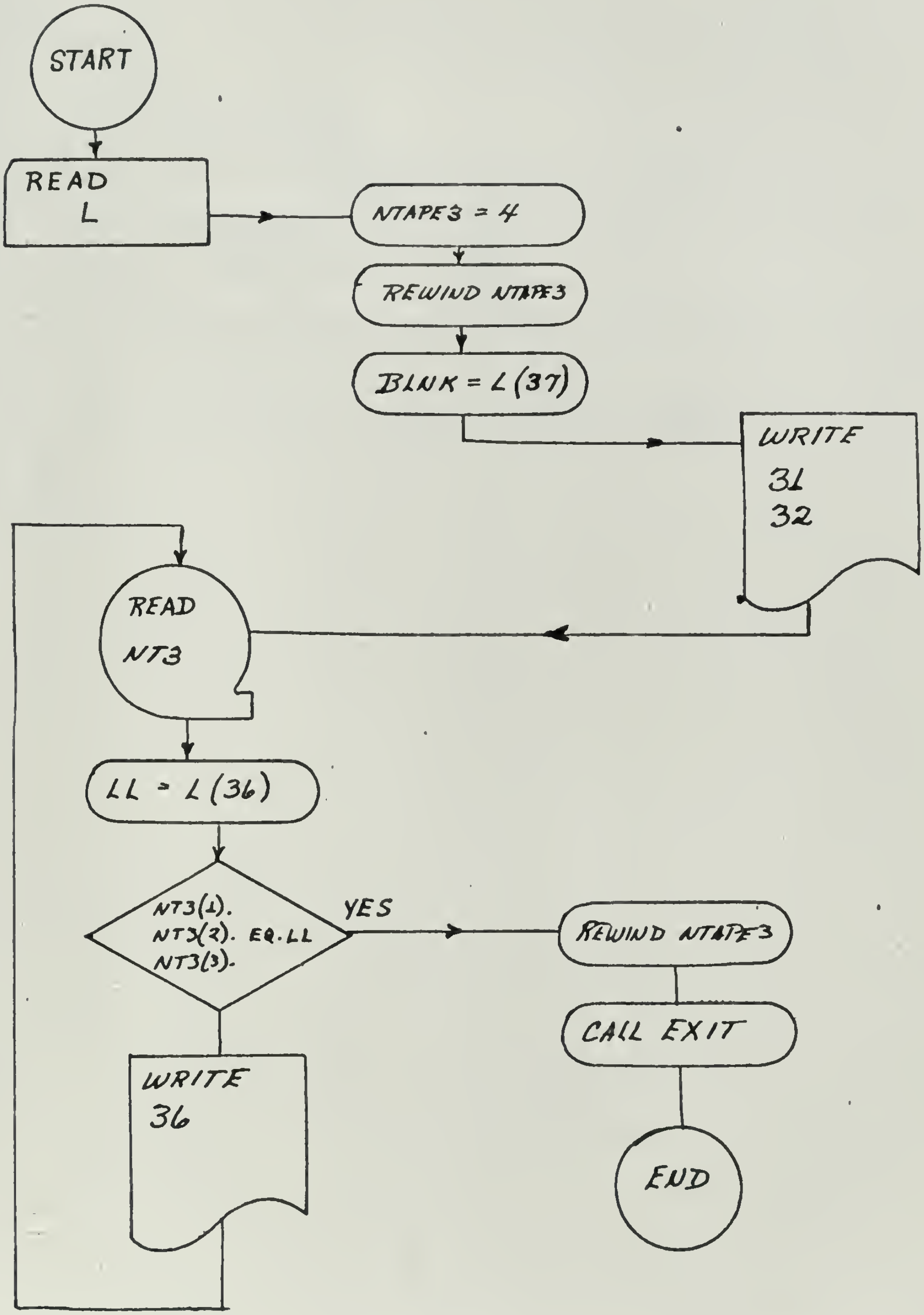

15
READ NT2
NT2(1). NT2(2). NT2(3). EQ. LL
YES
NO
READ NT1
NT2(26).EQ. NT1(1)
YES
NO
NT1(1). NT1(2). NT1(3). EQ. LL
YES
NO
REWIND NTAPE2
CALL EXIT
END
NT2(27) .NE. NT1(2)
YES
NO
NT2(28) .NE. NT1(3)
YES
NO
NT2(29) .NE. NT1(4)
YES
NO
LOC = NT2(25)
I = 1, 600
NRITE (I) = BLNK
LLOC = LOC+200
I = 1, 200
NRITE (I+200) = NT1(I+12)
L1 = LLOC -40
L2 = LLOC+70
LL1 = L1 + 1
LTEMP = L2-40
B
B
I=LTEMP, L2
NRITE(I).NE. BLNK
YES
NO
NRITE(L1).EQ.BLNK .OR. NRITE(LL1).EQ.BLNK
YES
NO
II = 1
I=LTEMP,L2
NRITE(I) = NT1(II+12)
II = II + 1
WRITE 53
REWIND NTAPE1
15

```
$IBFTC RITE     NCDECK
C   PRCGRAM TO WRITE NTAPE 2 AND KWIC
      CIMENSICN NT1(246),  NT2( C29), NRITE(6CC), NC1(18C, 29)
      CIMENSICN L(47)
      READ (5,1)  L
    1 FCRMAT (47A1)
      INTEGER BLNK
      NTAPE1 = 1
      NTAPE2 = 4
      REWINC NTAPE2
      BLNK = L(37)
      LL = L(36)
C -----
C   ROUTINE FOR WRITING SORTED KEYWORD LIST
      WRITE (6,14)
   14 FCRMAT (1H1,///////////,   20X, 32HWRITE OUT OF SCRTED KEYWORD FILF)
     1E)
   29 CCNTINUE
      CC 21  I=1,180
      ISAVE = I
      READ (NTAPE2)  (NT2(J), J=1,29)
      IF ((NT2(1).EQ.LL) .AND.(NT2(2).EQ.LL) .AND.(NT2(3).EQ.LL))GC TC23
      CC 22 J=1,29
   22 NC1(I,J) = NT2(J)
   21 CCNTINUE
      GC TC 26
   23 CC 25 I=ISAVE, 180
      CC 25 J=1,29
   25 NC1(I,J) = BLNK
      JEND = 711
   26 CCNTINUE
      CC 28  I= 1,60
      IF (I.EQ.1)  WRITE  (6,77)
   77 FCRMAT (1H1)
      WRITE (6,27)(NC1(I,J), J=1,29),    (NC1(I+60,JJ),JJ=1,29),
     1   (NC1(I+120,JJJ), JJJ=1,29    )
   27 FORMAT (5X, 29A1, 6X, 29A1, 6X, 29A1)
   28 CCNTINUE
      IF (JENC.EG. 711)  GO TO 3C
      GC TC 29
   3C CONTINUE
      REWINC NTAPE2
C -----
      PAUSE 40
      REWINC NTAPE1
C  RCUTINE FCR WRITING KWIC LIST
      WRITE (6,12)
   12 FORMAT (1H1,40X,20HPERMUTEC TITLE INDEX,/////)
      WRITE (6,13)
   13 FCRMAT (41X, 7HKEYWCRD, 72X, 11HCODE-YR-SCH,   /)
   15 READ (NTAPE2) (NT2(J), J=1,29)
      IF ((NT2(1).EQ.LL) .AND.(NT2(2).EQ.LL) .AND.(NT2(3).EQ.LL))
     1  GO TC 20
C -----
   41 CCNTINUE
```

```
      READ (NTAPE1)  (NT1(J), J=1,246)
      IF  (NT2(26).EQ.NT1(1))   GO TO 42
      IF ((NT1(1).EQ.LL).AND.(NT1(2).EQ.LL).AND.(NT1(3).EQ.LL))GO TO 20
      GO TO41
   42 CONTINUE
      IF (NT2(27).NE.NT1(2))  GO TO 41
      IF (NT2(28).NE.NT1(3))  GO TO 41
      IF (NT2(29).NE.NT1(4))  GO TO 41
      GO TO 45
   45 CONTINUE
C -----
      LOC = NT2(25)
C   LOC IS RELATIVE LOCATION OF KW BETWEEN 1 AND 200
      DO 51  I = 1,600
   51 NRITE (I) = BLNK
      LLOC = LOC +200
      DO 52   I = 1,200
   52 NRITE (I+200) = NT1(I+12)
      L1 = LLOC-40
      L2 = LLOC +70
C    WRAP AROUND PORTION
      LL1 = L1 +1
      LTEMP = L2 - 40
      DO 80  I = LTEMP , L2
      IF  (NRITE(I).NE. BLNK)   GO TO 88
   80 CONTINUE
      IF  ((NRITE(L1).EQ.BLNK).OR.(NRITE(LL1).EQ.BLNK))   GO TO 88
      II = 1
      DO 81  I = LTEMP , L2
      NRITE(I) = NT1(II + 12)
      II = II+1
   81 CONTINUE
   88 CONTINUE
C   ----
      WRITE (6,53) (NRITE(I), I=L1,L2) , (NT1(J), J=1,9 )
   53 FORMAT  ( 1X, 111A1,  8X, 8A1,A3 )
      REWIND NTAPE1
      GO TO 15
   20 CONTINUE
      REWIND NTAPE2
      CALL EXIT
      END
```

Appendix A (continued)

FLOW CHART FOR PROGRAM TO WRITE-OUT TAPE 3 – THE AUTHOR LISTING



```
      SOURCE STATEMENT

$IBFTC RITE    NODECK
C    PROGRAM TO WRITE NTAPES 3
      DIMENSION NT1(246), NT2(246),  NT3(68),  NRITE(600)
      DIMENSION L(47)
      READ (5,1)  L
    1 FORMAT (47A1)
      INTEGER BLNK
      NTAPE3 = 4
      REWIND NTAPE3
      BLNK = L(37)
C    ROUTINE FOR AUTHOR LISTING
      WRITE (6,31)
   31 FORMAT (1H1, 40X, 14HAUTHOR LISTING, /////)
      WRITE (6,32)
   32 FORMAT (10X, 6HAUTHOR,  40X, 4HCODE, / )
   35 READ (NTAPE3)  (NT3(J), J= 1,68)
      LL = L(36)
      IF ((NT3(1).EQ.LL).AND.(NT3(2).EQ.LL).AND.(NT3(3).EQ.LL))
     1  GO TO 40
      WRITE (6,36)  (NT3(I),I=35,67), (NT3(J), J=21,29), (NT3(K),K=1,20)
   36 FORMAT (10X, 33A1, 13X, 8A1,A3,  15X,  20A1)
      GO TO 35
   40 CONTINUE
      REWIND NTAPE3
      CALL EXIT
      END
```

APPENDIX A (continued)

```
C    SUBROUTINE PACK
C --------
        CALL PACK (NPAK, N1,N2,N3,N4,N5,N6 )
C --------
$IBMAP PAK     NODECK
       ENTRY   PACK
PACK   TRA     **
       SXA     GEORGE,4
       LAC     *-2,4
       PCS*    3,4,0
       SAC*    2,4,0
       PCS*    4,4,0
       SAC*    2,4,1
       PCS*    5,4,0
       SAC*    2,4,2
       PCS*    6,4,0
       SAC*    2,4,3
       PCS*    7,4,0
       SAC*    2,4,4
       PCS*    8,4,0
       SAC*    2,4,5
GEORGE AXT     **,4
       TRA     PACK
       END
```

```
C    SUBROUTINE UNPACK
C ---------
        CALL UNPACK (NPAK, N1,N2,N3,N4,N5,N6 )
C ---------
$IBMAP UNPAK   NODECK
       ENTRY   UNPACK
UNPACK TRA     **
       SXA     GEORGE,4
       LAC     *-2,4
       PCS*    2,4,0
       SAC*    3,4,0
       PCS*    2,4,1
       SAC*    4,4,0
       PCS*    2,4,2
       SAC*    5,4,0
       PCS*    2,4,3
       SAC*    6,4,0
       PCS*    2,4,4
       SAC*    7,4,0
       PCS*    2,4,5
       SAC*    8,4,0
GEORGE AXT     **,4
       TRA     UNPACK
       END
```

APPENDIX A (continued)

CONTROL CARDS FOR SORT

```
$JOB           0694,DRURY
$PAUSE 20
$TIME          010
$IBSRT         NOTYPE
      FILE,INPUT/2,  REELS/1,   MODE/B,  BLOCKSIZE/030, UNLOAD
      FILE,OUTPUT,  MODE/B,  BLOCKSIZE/030,   UNLOAD
      RECORD,  TYPE/F, LENGTH/030,  FIELD/(6,36B,36B,36B,36B,36B,36B,
1      36B,36B,36B,36B  )
      SORT,  FILE/2, SEQ/C,  ORDER/2,  FIELD/(2,3,4,5,6,7,8,9,10,11)
      SYSTEM,INPUTCHANNEL/S.SU04,  OUTPUT CHANNEL/A,  MERGE CHANNEL/A
      OPTION , NODUMP,  NOCKPT
      END
```

APPENDIX A (continued)

DISCARD DICTIONARY

```
OF
THE
AND
IN
ON
BY
A
WITH
FOR
FROM
TO
SOME
AS
AT
AN
Y.
N.
-
.
--
STUDY
DURING
USING
SURVEY
EFFECT
RELATION
BETWEEN
EXPERIMENT
PHENOMENA
PRODUCTS
INTO
TYPE
RATE
DROP
ITS
SYSTEMS
ARISING
DETAILED
LOCAL
BED
APPLIED
UNDER
SIZE
STUDIES
PLANT
```

Appendix B

SAMPLE INPUT DATA

```
A042 AMBROSE, TOMMY W.                  1957
      LOCAL SHELL-SIDE HEAT TRANSFER COEFFICIENTS IN
       BAFFLED TUBULAR HEAT EXCHANGERS
        OREGON STATE COLLEGE

A043 AMDUR, E.                          1944
      THE DEHYDRATION OF VEGETABLES
        UNIVERSITY OF MINNESOTA

A044 AMERIGO, FRANK TESI                1943
      KINETIC STUDIES OF THE ADSORPTION OF PHENOL BY
       ACTIVATED CARBON IN A PACKED TOWER
        UNIVERSITY OF PITTSBURGH

A045 AMICK, E. H., JR.                  1939
      PRESSURE-VOLUME-TEMPERATURE RELATIONSHIPS OF A
       METHANE-ISOPENTANE MIXTURE
        YALE UNIVERSITY

A046 AMIR-YEGAHEH, A.                   1962
      ON DETERMINATION OF VAPOR-LIQUID EQUILIBRIUM
       PHASE DISTRIBUTION RATIOS OF PETROLEUM OILS
        OKLAHOMA STATE UNIVERSITY

A047 ANDERSEN, L. B.                    1954
      ABSORPTION-OXIDATION PROCESSES IN DISPERSED MEDIA
        UNIVERSITY OF ILLINOIS

A048 ANDERSON, D. G., JR.               1940
      VOID VOLUME AND FLOW RESISTANCE OF BEDS OF
       PARTICLES
        COLUMBIA UNIVERSITY

A049 ANDERSON, DONALD KEITH             1959
      MUTUAL DIFFUSION IN ASSOCIATED BINARY LIQUID
       MIXTURES
        UNIVERSITY OF WASHINGTON

A050 ANDERSON, F. A.                    1947
      STUDY OF METHODS FOR PROCESSING TALL OIL
        LOUISIANA STATE UNIVERSITY

A051 ANDERSON, J. E.                    1953
      EVALUATION OF CATALYSTS FOR HYDROCARBON
       OXIDATION
        IOWA STATE UNIVERSITY

A052 ANDERSON, J. E.                    1955
      MASS TRANSFER IN A DISTILLATION COLUMN
        MASSACHUSETTS INSTITUTE OF TECHNOLOGY

A053 ANDERSON, J. W.                    1950
      PREPARATION OF NITROGENOUS FERTILIZERS BY
       TREATMENT OF CELLULOSIC MATERIALS WITH AMMONIA
        IOWA STATE UNIVERSITY
```

SCHOOL DICTIONARY

001	TEXAS AGRICULTURE AND HECHANICAL COLLEGE	073	TEAAS COLLEGE OF ARTS AND INDUSTRY
002	ARIZONA STATE UNIVERSITY	074	TEXAS TECHNOLOGICAL COLLEGE
003	AUBURN UNIVERSITY	075	TRI-STATE COLLEGE
004	BUCKNELL UNIVERSITY	076	TUCTS UNIVERSITY
005	BRIGHAH YOUNG UNIVERSITY	077	TULANE UNIVERSITY
006	CALICORNIA INSTITUTE OF TECHNOLOGY	078	UNIVERSITY OC ALABAMA
007	CARNEGIE INSTITUTE OC TECHNOLOGY	079	UNIVERSITY OF ALBERTA
008	CASE INSTITUTE OC TECHNOLOGY	080	UNIVERSITY OC ARIZONA
009	CATHOLIC UNIVERSITY OF AHERICA	081	UNIVERSITY OC ARKANSAS
010	CITY COLLEGE OF NEW YORK	082	UNIVERSITY OF BRITISH COLUMBIA
011	CLARKSON COLLEGE OF TECHNOLOGY	083	UNIVERSITY OC CALIFORNIA AT BERKELEY
012	CLEHSON AGRICULTURAL COLLEGE	084	UNIVERSITY OF CALIFORNIA AT LOS ANGELES
013	COLORAOO SCHOOL OF MINES	085	UNIVERSITY OC CINCINNATI
014	COLUMBIA UNIVERSITY	086	UNIVERSITY OF COLORADO
015	COOPER UNION	087	UNIVERSITY OF CONNECTICUT
016	CORNELL UNIVERSITY	088	UNIVERSITY OC DAYTON
017	OREXEL INSTITUTE OF TECHNOLOGY	089	UNIVERSITY OF DELAWARE
018	ESSEX COLLEGE	090	UNIVERSITY OF OENVER
019	FENN COLLEGE	091	UNIVERSITY OF DETROIT
020	GEORGIA INSTITUTE OC TECHNOLOGY	092	UNIVERSITY OF FLORIDA
021	GONZAGA UNIVERSITY	093	UNIVERSITY OF HOUSTON
022	GROVE CITY COLLEGE	094	UNIVERSITY OF IOAHO
023	ILLINOIS INSTITUTE OC TECHNOLOGY	095	UNIVERSITY OF ILLINOIS
024	INOIANA TECHNOLOGICAL INSTITUTE	096	UNIVERSITY OC KANSAS
025	IOWA STATE UNIVERSITY	097	UNIVERSITY OF KENTUCKY
026	JOHNS HOPKINS UNIVERSITY	098	UNIVERSITY OF LOUISVILLE SPEED SCIENTIFIC SCHOOL
027	KANSAS STATE UNIVERSITY	099	UNIVERSITY OC MAINE
028	LAFAYETTE UNIVERSITY	100	UNIVERSITY OF MARYLAND
029	LAHAR STATE COLLEGE OF TECHNOLOGY	101	UNIVERSITY OF HASSACHUSETTS
030	LAVAL UNIVERSITY	102	UNIVERSITY OF MICHIGAN
031	LEHIGH UNIVERSITY	103	UNIVERSITY OF MINNESOTA
032	LOUISIANA POLYTECHNIC INSTITUTE	104	UNIVERSITY OF HISSISSIPPI
033	LOUISIANA STATE UNIVERSITY	105	UNIVERSITY OF MISSOURI
034	HCGILL UNIVERSITY	106	UNIVERSITY OF HONTREAL
035	HCMASTERS UNIVERSITY	107	UNIVERSITY OF NEBRASKA
036	HANHATTAN COLLEGE	108	UNIVERSITY OF NEW HAHPSHIRE
037	HASSACHUSETTS INSTITUTE OC TECHNOLOGY	109	UNIVERSITY OF NEW HEXICO
038	HICHIGAN COLLEGE OF HINING ANO TECHNOLOGY	110	UNIVERSITY OF NORTH OAKOTA
039	MICHIGAN STATE UNIVERSITY	111	UNIVERSITY OC NOTRE OAME
040	MISSISSIPPI STATE UNIVERSITY	112	UNIVERSITY OF OKLAHOHA
041	HISSOURI SCHOOL OF HINES ANO METALLURGY	113	UNIVERSITY OF OTTAWA
042	HONTANA STATE COLLEGE	114	UNIVERSITY OF PENNSYLVANIA
043	NEWARK COLLEGE OC ENGINEERING	115	UNIVERSITY OF PITTSBURGH
044	NEW HEXICO STATE UNIVERSITY	116	UNIVERSITY OF PUERTO RICO
045	NEW YORK UNIVERSITY	117	UNIVERSITY OF RHODE ISLAND
046	NORTH CAROLINA STATE COLLEGE	118	UNIVERSITY OF ROCHESTER
047	NORTHEASTERN UNIVERSITY	119	UNIVERSITY OC SASKATCHEWAN
048	NORTHWESTERN UNIVERSITY	120	UNIVERSITY OF SOUTHWESTERN LOUISANA
049	NOVA SCOTIA TECHNOLOGICAL COLLEGE	121	UNIVERSITY OF SOUTH CAROLINA
050	OHIO STATE UNIVERSITY	122	UNIVERSITY OF SOUTHERN CALIFORNIA
051	OHIO UNIVERSITY	123	UNIVERSITY OF TENNESSEE
052	OKLAHOHA STATE UNIVERSITY	124	UNIVERSITY OF TEXAS
053	OREGON STATE COLLEGE	125	UNIVERSITY OF TOLEDO
054	PENNSYLVANIA STATE UNIVERSITY	126	UNIVERSITY OF TORONTO
055	POLYTECHNIC INSTITUTE OF BROOKLYN	127	UNIVERSITY OF TULSA
056	PRATT INSTITUTE	128	UNIVERSITY OF UTAH
057	PRINCETON UNIVERSITY	129	UNIVERSITY OF VIRGINIA
058	PURDUE UNIVERSITY	130	UNIVERSITY OF WASHINGTON
059	QUEENS UNIVERSITY	131	UNIVERSITY OF WISCONSIN
060	RENSSELAER POLYTECHNIC INSTITUTE	132	VANDERBILT UNIVERSITY
061	RICE INSTITUTE	133	VILLANOVA UNIVERSITY
062	ROSE POLYTECHNIC INSTITUTE	134	VIRGINIA POLYTECHNIC INSTITUTE
063	ROYAL MILITARY COLLEGE OF CANADA	135	WASHINGTON STATE UNIVERSITY
064	RUTGERS UNIVERSITY	136	WASHINGTON UNIVERSITY
065	SAN JOSE STATE COLLEGE	137	WAYNE STATE UNIVERSITY
066	SEATTLE UNIVERSITY	138	WEST VIRGINIA INSTITUTE OF TECHNOLOGY
067	SOUTH DAKOTA SCHOOL OF HINES AND TECHNOLOGY	139	WEST VIRGINIA UNIVERSITY
068	STANFORO UNIVERSITY	140	WORCESTER POLYTECHNIC INSTITUTE
069	STATE UNIVERSITY OF IOWA	141	YALE UNIVERSITY
070	STATE UNIVERSITY OF NEW YORK AT BUFFALO	142	UNIVERSITY OF LOUISVILLE
071	STEVENS INSTITUTE OF TECHNOLOGY	143	THE INSTITUTE OF PAPER CHEMISTRY
072	SYRACUSE UNIVERSITY	144	UNIVERSITY OF IOWA

Appendix C

```
                                         PERMUTED TITLE INDEX

                                         KEYWORD                                                                       CODE-YR-SCH

   FOR STUDYING CHANNELING IN A PACKED GAS ABSCRPTION TOWER                A NEW METHOD FOR STUDYING CHANNELING IN A  A031 52 058
                                         ABSCRPTION-OXIDATION PROCESSES IN DISPERSED MEDIA                               A047 54 095
  A STUDY OF THE CRITICAL HEAT FLUX IN AN ACCELERATING POOL BOILING SYSTEM                                               A010 62 130
    ERING STUDY OF UNFRACTIONATED POLYVINYL ACETATE                          A LIGHT SCATTERING STUDY OF UNFRACTIONATE   A022 59 102
   APROIC ACID- CAPRYLIC ACID MIXTURES AND ACETIC ACID BINARY SYSTEMS      THERMODYNAMIC CORRELATION AND PREDICTION     A005 57 054
   ACID- CAPRYLIC ACID MIXTURES AND ACETIC ACID BINARY SYSTEMS             THERMODYNAMIC CORRELATION AND PREDICTION     A005 57 054
  O EQUILIBRIA FOR CAPROIC ACID- CAPRYLIC ACID MIXTURES AND ACETIC ACID BINARY SYSTEMS                                   A005 57 054
   OF VAPOR-LIQUID EQUILIBRIA FOR CAPROIC ACID- CAPRYLIC ACID MIXTURES AND ACETIC ACID BINARY SYSTEMS                    A005 57 054
   OF ETHYLENE BY MEANS OF DILUTE MINERAL ACIDS AT HIGH PRESSURES                                                        A068 39 037
                          PRESSURE DROPS ACROSS SUBMERGED ORIFICES WITH PSEUDO-PLASTIC NON-NEWTONIAN FLUIDS             A057 53 060
   STUDIES OF THE ADSORPTION OF PHENOL BY ACTIVATED CARBON IN A PACKED TOWER                                             A044 43 115
   IBRIA OF OXYGEN AND NITROGEN ON VARIOUS ADSORBENTS                       ADSORPTION EQUILIBRIA OF OXYGEN AND NITRO    A038 54 045
                      KINETIC STUDIES OF THE ADSORPTION OF PHENOL BY ACTIVATED CARBON IN A PACKED TOWER                  A044 43 115
                                         ADSORPTION EQUILIBRIA OF OXYGEN AND NITROGEN ON VARIOUS ADSORBENTS              A038 54 045
                     AN EQUATION FOR THE ADSORPTION WAVE                                                                 A064 52 026
                                         ADSORPTION OF VAPORS BY METALLIC OXIDES. ITS BEARING ON THE CATALYSIS O         A040 24 144
   O FLAME TEMPERATURES OF LAMINAR PROPANE AIR FLAMES FORM STROBOSCOPICALLY ILLUMINATED PARTICLE TRACKS                  A054 49 131
              THE ELECTROLYSIS OF SOME LIQUID ALLOYS                                                                     A065 61 102
   FORMATION OF CHEMICAL FILM DEPOSITS ON ALUMINUM SURFACES                                                              A062 52 001
   TREATMENT OF CELLULOSIC MATERIALS WITH AMMONIA                                                                        A053 50 025
   NSITY OF MIXTURES OF CARBON DIOXIDE AND ARGON AT 50 DEGREES AND 50 TO 1000 ATMOSPHERES                                A004 57 058
                     MUTUAL DIFFUSION IN ASSOCIATED BINARY LIQUID MIXTURES                                               A049 59 130
   AND ARGON AT 50 DEGREES AND 50 TO 1000 ATMOSPHERES                                                                    A004 57 058
                                         ATOMIZATION OF WATER WITH SPINNING DISKS                                        A016 50 131
   HELL-SIDE HEAT TRANSFER COEFFICIENTS IN BAFFLED TUBULAR HEAT EXCHANGERS                                               A042 57 053
       THE CELLULOSE AND LIGNIN OF INDIA BAMBOO WOOD                                                                     A020 48 130
   PTION OF VAPORS BY METALLIC OXIDES. ITS BEARING ON THE CATALYSIS OF ESTER FORMATION                                   A040 24 144
      VOID VOLUME AND FLOW RESISTANCE OF BEDS OF PARTICLES                                                               A048 40 014
           MASS TRANSFER RATES IN PACKED BEDS                                                                            A033 60 039
                          THE TRANSIENT BEHAVIOR OF SINGLE-PHASE, NATURAL- CIRCULATION LOOP SYSTEMS                      A037 54 103
           MUTUAL DIFFUSION IN ASSOCIATED BINARY LIQUID MIXTURES                                                         A049 59 130
   CAPRYLIC ACID MIXTURES AND ACETIC ACID BINARY SYSTEMS                                                                 A005 57 054
     NEAT TRANSFER AT HIGH RATES TO WATER BOILING OUTSIDE CYLINDERS                                                      A013 48 037
   TICAL HEAT FLUX IN AN ACCELERATING POOL BOILING SYSTEM                   A STUDY OF THE CRITICAL HEAT FLUX IN AN A    A010 62 130
                                  NORMAL BURNING VELOCITIES AND FLAME TEMPERATURES OF LAMINAR PROPANE AIR FLAMES         A054 49 131
            VAPOR PHASE NITRATION OF BUTANE IN A FUSED SALT REACTOR                                                      A009 61 000
                      THE DEVELOPMENT OF CALCIUM CARBONATE-IRON OXIDE PROTECTIVE COATINGS ON IRON                        A002 58 039
   EDICTION OF VAPOR-LIQUID EQUILIBRIA FOR CAPROIC ACID- CAPRYLIC ACID MIXTURES AND ACETIC ACID BINARY SYSTEMS           A005 57 054
   POR-LIQUID EQUILIBRIA FOR CAPROIC ACID- CAPRYLIC ACID MIXTURES AND ACETIC ACID BINARY SYSTEMS                         A005 57 054
             THE DENSITY OF MIXTURES OF CARBON DIOXIDE AND ARGON AT 50 DEGREES AND 50 TO 1000 ATMOSPHERES                A004 57 058
   C THE ADSORPTION OF PHENOL BY ACTIVATED CARBON IN A PACKED TOWER                                                      A044 43 115
             THE DEVELOPMENT OF CALCIUM CARBONATE-IRON OXIDE PROTECTIVE COATINGS ON IRON                                 A002 58 039
   PACE REQUIREMENTS FOR THE COMBUSTION OF CARBURETTED WATER GAS IN LUMINOUS FLAMES                                      A039 34 131
    BY METALLIC OXIDES. ITS BEARING ON THE CATALYSIS OF ESTER FORMATION                                                  A040 24 144
                          EVALUATION OF CATALYSTS FOR HYDROCARBON OXIDATION                                              A051 53 025
   BUTYL MERCAPTAN OVER VANADIUM PENTOXIDE CATALYSTS                        THE VAPOR PHASE OXIDATION OF N-BUTYL MERC    A012 42 026
   ENGINEERING DEVELOPMENT OF PHOTOVOLTAIC CELLS                            THE ENGINEERING DEVELOPMENT OF PHOTOVOLTA    A036 32 014
                                     THE CELLULOSE AND LIGNIN OF INDIA BAMBOO WOOD                                       A020 48 130
     THERMODYNAMIC STUDIES IN THE SYSTEM CELLULOSE- WATER, STUDIES IN THE SYSTEM COTTON LINTERS-WATER                    A056 62 130
   NITROGENOUS FERTILIZERS BY TREATMENT OF CELLULOSIC MATERIALS WITH AMMONIA                                             A053 50 025
                   A NEW METHOD FOR STUDYING CHANNELING IN A PACKED GAS ABSORPTION TOWER                                 A031 52 058
                                         CHARACTERIZATION OF MULTIPLE VARIABLE PROCESS SYSTEMS FROM RANDOM INPUT         A066 62 057
                       THE FORMATION OF CHEMICAL FILM DEPOSITS ON ALUMINUM SURFACES                                      A062 52 001

                   HYDROGENATION WITH PALLADIUM DIAPHRAGMS                                                               A063 60 131
   A STUDY OF THE VAPOR-PHASE NITRATION OF PARAFFINS                                                                     A032 48 058
   LANES FORM STROBOSCOPICALLY ILLUMINATED PARTICLE TRACKS                  NORMAL BURNING VELOCITIES AND FLAME TEMPE    A054 49 131
   O VOLUME AND FLOW RESISTANCE OF BEDS OF PARTICLES                                                                     A048 40 014
                 INTERFACIAL TENSION BY PENDANT DROPS                                                                    A059 38 037
   TION OF N-BUTYL MERCAPTAN OVER VANADIUM PENTOXIDE CATALYSTS              THE VAPOR PHASE OXIDATION OF N-BUTYL MERC    A012 42 026
   CK POROUS MATERIALS IN THE FALLING RATE PERIOD TREATMENT OF MIXTURES WITH AN INDEFINITE NUMBER OF COMPONENTS          A007 62 060
              LIQUID PHASE CRACKING OF PETROLEUM                                                                         A003 30 115
   LUBRICATING PROPERTIES OF GREASES FROM PETROLEUM OILS                                                                 A034 32 016
   QUILIBRIUM PHASE DISTRIBUTION RATIOS OF PETROLEUM OILS                    ON DETERMINATION OF VAPOR-LIQUID EQUILIBR   A046 62 052

                                    MASS TRANSFER IN A DISTILLATION COLUMN                                               A052 55 037
                                    HEAT TRANSFER IN A FLUIDIZED SOLIDS SYSTEM                                           A067 53 144
                                     THE TRANSIENT BEHAVIOR OF SINGLE-PHASE, NATURAL- CIRCULATION LOOP SYSTEMS           A037 54 103
   EPARATION OF NITROGENOUS FERTILIZERS BY TREATMENT OF CELLULOSIC MATERIALS WITH AMMONIA                                A053 50 025
   US MATERIALS IN THE FALLING RATE PERIOD TREATMENT OF MIXTURES WITH AN INDEFINITE NUMBER OF COMPONENTS                 A007 62 060
   YROLYSIS OF NITROGEN DIOXIDE IN A SHOCK TUBE                             THE RATE OF PYROLYSIS OF NITROGEN DIOXIDE    A041 62 068
              HEAT TRANSFER IN SUBMERGED TUBE EVAPORATION                                                                A025 41 037
   DISTRIBUTION ON HEAT TRANSFER IN SMOOTH TUBES                             EFFECT OF INITIAL VELOCITY DISTRIBUTION O   A001 57 102
   E HEAT TRANSFER COEFFICIENTS IN BAFFLED TUBULAR HEAT EXCHANGERS                                                       A042 57 053
          HOLDING TIME FUNCTIONS OF SHORT TUBULAR VESSELS                                                                A018 57 031
         A LIGHT SCATTERING STUDY OF UNFRACTIONATED POLYVINYL ACETATE                                                    A022 59 102
                   THE FLUIDIZATION OF UNIFORM SMOOTH SPHERES IN LIQUID MEDIA                                            A015 61 045
                            RECOVERY OF URANIUM FROM SUPERPHOSPHATE                                                      A061 55 025
   ASE OXIDATION OF N-BUTYL MERCAPTAN OVER VANADIUM PENTOXIDE CATALYSTS  THE VAPOR PHASE OXIDATION OF N-BUTYL MERC       A012 42 026
                                     THE VAPOR PHASE OXIDATION OF N-BUTYL MERCAPTAN OVER VANADIUM PENTOXIDE CATA         A012 42 026
                                         VAPOR PHASE NITRATION OF BUTANE IN A FUSED SALT REACTOR                         A009 61 000
                  ON DETERMINATION OF VAPOR-LIQUID EQUILIBRIUM PHASE DISTRIBUTION RATIOS OF PETROLEUM OILS               A046 62 052
                                         VAPOR-LIQUID EQUILIBRIA N-HEPTANE-SOLVENT                                       A060 42 124
   MODYNAMIC CORRELATION AND PREDICTION OF VAPOR-LIQUID EQUILIBRIA FOR CAPROIC ACID- CAPRYLIC ACID MIXTURES AND AC       A005 57 054
                        A STUDY OF THE VAPOR-PHASE NITRATION OF PARAFFINS                                                A032 48 058
                         ADSORPTION OF VAPORS BY METALLIC OXIDES. ITS BEARING ON THE CATALYSIS OF ESTER FORMAT           A040 24 144
           CHARACTERIZATION OF MULTIPLE VARIABLE PROCESS SYSTEMS FROM RANDOM INPUTS                                      A066 62 057
   ON EQUILIBRIA OF OXYGEN AND NITROGEN ON VARIOUS ADSORBENTS                ADSORPTION EQUILIBRIA OF OXYGEN AND NITRO   A038 54 045
                 SOLVENT EXTRACTION OF VEGETABLE OILS                                                                    A019 51 055
                   THE DEHYDRATION OF VEGETABLES                                                                         A043 44 103
                          NORMAL BURNING VELOCITIES AND FLAME TEMPERATURES OF LAMINAR PROPANE AIR FLAMES FORM ST         A054 49 131
   BILIZED FLAMES AT LOW PRESSURE AND HIGH VELOCITIES                        REACTION, FLOW, AND RADIATION IN ENCLOSED   A069 53 089
                     EFFECT OF INITIAL VELOCITY DISTRIBUTION ON HEAT TRANSFER IN SMOOTH TUBES                            A001 57 102
                     IGNITION OF HIGH VELOCITY GAS STREAMS BY MEANS OF HEATED RODS                                       A021 49 037
   HOLDING TIME FUNCTIONS OF SHORT TUBULAR VESSELS                           HOLDING TIME FUNCTIONS OF SHORT TUBULAR V   A018 57 031
                                         VOID VOLUME AND FLOW RESISTANCE OF BEDS OF PARTICLES                            A048 40 014
                                    VOID VOLUME AND FLOW RESISTANCE OF BEDS OF PARTICLES                                 A048 40 014
   INAR FLOW HEAT TRANSFER WITH PRESCRIBED WALL HEAT FLUX                    EXPERIMENTAL STUDY OF LAMINAR FLOW HEAT T   A026 62 048
   MENTS FOR THE COMBUSTION OF CARBURETTED WATER GAS IN LUMINOUS FLAMES      SPACE REQUIREMENTS FOR THE COMBUSTION OF    A039 34 131
                    ATOMIZATION OF WATER WITH SPINNING DISKS                                                             A016 50 131
         HEAT TRANSFER AT HIGH RATES TO WATER BOILING OUTSIDE CYLINDERS                                                  A013 48 037
   YNAMIC STUDIES IN THE SYSTEM CELLULOSE- WATER, STUDIES IN THE SYSTEM COTTON LINTERS-WATER                             A056 62 130
            AN EQUATION FOR THE ADSORPTION WAVE                                                                          A064 52 026
   HE CELLULOSE AND LIGNIN OF INDIA BAMBOO WOOD                              THE CELLULOSE AND LIGNIN OF INDIA BAMBOO    A020 48 130
```

```
                              MASTER RECORD BIBLIOGRAPHIC LISTING

CODE YR SCH                     TITLE                                                                   AUTHOR

A001 57 102   EFFECT OF INITIAL VELOCITY DISTRIBUTION ON HEAT TRANSFER IN SMOOTH TUBES                  *ABBRECHT, PETER HERMAN
A002 58 039   THE DEVELOPMENT OF CALCIUM CARBONATE-IRON OXIDE PROTECTIVE COATINGS ON IRON               *ABDULLAH, M. U.
A003 30 115   LIQUID PHASE CRACKING OF PETROLEUM                                                        *ABEC, RAYMOND LEICESTER
A004 57 058   THE DENSITY OF MIXTURES OF CARBON DIOXIDE AND ARGON AT 50 DEGREES AND 50 TO 1000 ATMOSPHERES
                                                                                                        *ABRAHAM, W. H.
A005 57 054   THERMODYNAMIC CORRELATION AND PREDICTION OF VAPOR-LIQUID EQUILIBRIA FOR CAPROIC ACID- CAPRYLIC ACID MIXTURES AND ACET
             IC ACID BINARY SYSTEMS                                                                     *ACCIARRI, J. A.
A007 62 060   THE MECHANISM OF DRYING THICK POROUS MATERIALS IN THE FALLING RATE PERIOD TREATMENT OF MIXTURES WITH AN INDEFINITE NU
             MBER OF COMPONENTS                                                                         *ADAMS, EDWARD F.
A008 28 037   THE REACTION OF LIME AND WATER                                                            *ADAMS, F. W.
A009 61 000   VAPOR PHASE NITRATION OF BUTANE IN A FUSED SALT REACTOR                                   *ADAMS, FRANK SLATES, JR.
A010 62 130   A STUDY OF THE CRITICAL HEAT FLUX IN AN ACCELERATING POOL BOILING SYSTEM                  *ADAMS, JIM M.
A011 50 095   CHEMICAL REACTION RATES UNDER HIGH PRESSURE                                               *ADAMS, R. H.
A012 42 026   THE VAPOR PHASE OXIDATION OF N-BUTYL MERCAPTAN OVER VANADIUM PENTOXIDE CATALYSTS          *ADDIS, GILBERT IRVING
A013 48 037   HEAT TRANSFER AT HIGH RATES TO WATER BOILING OUTSIDE CYLINDERS                            *ADDCKS, J. N.
A014 61 048   HEAT TRANSFER IN CONSOLIDATED POROUS MEDIA WITH FLOWING FLUIDS                            *ADIVARAHAN, PANCHANADHAM
A015 61 045   THE FLUIDIZATION OF UNIFORM SMOOTH SPHERES IN LIQUID MEDIA                                *ADLER, IRWIN LEROY
A016 50 131   ATOMIZATION OF WATER WITH SPINNING DISKS                                                  *ADLER, CHARLES RICHARD
A017 59 072   THE FORMATION OF DETONATION IN SATURATED MIXTURE OF KNALLGAS AND STEAM                    *ADLER, LEONARD B.
A018 57 031   HOLDING TIME FUNCTIONS OF SHORT TUBULAR VESSELS                                           *ADLER, R. J.
A019 51 055   SOLVENT EXTRACTION OF VEGETABLE OILS                                                      *AGARWAL, JAGDISH
A020 48 130   THE CELLULOSE AND LIGNIN OF INDIA BAMBOO WOOD                                             *AGGARWALA, JAGDISH PHANUDRA
A021 49 037   IGNITION OF HIGH VELOCITY GAS STREAMS BY MEANS OF HEATED RODS                             *AHESILA, G. A.
A022 59 102   A LIGHT SCATTERING STUDY OF UNFRACTIONATED POLYVINYL ACETATE                              *AHLBECK, RICHARD A.
A023 57 072   FREE SETTLING OF FIBERS IN FLUIDS                                                         *AIDUN, ARDESHIR R.
A024 51 102   A KINETIC STUDY OF THE SYNTHESIS OF METHANE                                               *AKERS, WILLIAM WALTER
A025 41 037   HEAT TRANSFER IN SUBMERGED TUBE EVAPORATION                                               *AKIN, G. A.
A026 62 048   EXPERIMENTAL STUDY OF LAMINAR FLOW HEAT TRANSFER WITH PRESCRIBED WALL HEAT FLUX           *AKINS, RICHARD G.
A027 50 050   LIQUID-VAPOUR EQUILIBRIUM COMPOSITION RELATIONSHIPS IN THE ETHANE-CYCLOHEXANE SYSTE*ALBERT, ROBERT CYER
A028 53 139   PRESSURE DROP IN FLOW OF DENSE COAL-AIR MIXTURES                                          *ALBRIGHT, CHARLES W.
A029 50 102   THERMODYNAMIC PROPERTIES OF FREON 13                                                      *ALBRIGHT, LYLE FREDERIC
A030 15 014   THE TIME FACTOR IN MAKING OIL GAS                                                         *ALEXANDER, C. H.
A031 52 058   A NEW METHOD FOR STUDYING CHANNELING IN A PACKED GAS ABSORPTION TOWER                     *ALEXANDER, L. C., JR.
A032 48 058   A STUDY OF THE VAPOR-PHASE NITRATION OF PARAFFINS                                         *ALEXANDER, L. G.
A033 60 039   MASS TRANSFER RATES IN PACKED BEDS                                                        *AL-KHUDAYRI, TAKIU
A034 32 016   LUBRICATING PROPERTIES OF GREASES FROM PETROLEUM OILS                                     *ALLEN, HAROLD DWAINE
A035 48 102   THE THROUGH-DRYING OF POROUS MEDIA                                                        *ALLERTON, JOSEPH
A036 32 014   THE ENGINEERING DEVELOPMENT OF PHOTOVOLTAIC CELLS                                         *ALPERN, D. K.
A037 54 103   THE TRANSIENT BEHAVIOR OF SINGLE-PHASE, NATURAL- CIRCULATION LOOP SYSTEMS                 *ALSTAC, C. D.
A038 54 045   ADSORPTION EQUILIBRIA OF OXYGEN AND NITROGEN ON VARIOUS ADSORBENTS                        *ALTMAN, M.
A039 34 131   SPACE REQUIREMENTS FOR THE COMBUSTION OF CARBURETTED WATER GAS IN LUMINOUS FLAMES         *ALTPETER, ROGER JAMES
A040 24 144   ADSORPTION OF VAPORS BY METALLIC OXIDES. ITS BEARING ON THE CATALYSIS OF ESTER FORMATION
                                                                                                        *ALVARADO, A. M.
A041 62 068   THE RATE OF PYROLYSIS OF NITROGEN DIOXIDE IN A SHOCK TUBE                                 *ALYEA, FREDERICK N.
A042 57 053   LOCAL SHELL-SIDE HEAT TRANSFER COEFFICIENTS IN BAFFLED TUBULAR HEAT EXCHANGERS            *AMBROSE, TOMMY W.
A043 44 103   THE DEHYDRATION OF VEGETABLES                                                             *AMDUR, E.
A044 43 115   KINETIC STUDIES OF THE ADSORPTION OF PHENOL BY ACTIVATED CARBON IN A PACKED TOWER         *AMERIGO, FRANK JESI
A045 39 141   PRESSURE-VOLUME-TEMPERATURE RELATIONSHIPS OF A METHANE-ISOPENTANE MIXTURE                 *AMICK, E. H., JR.
A046 62 052   ON DETERMINATION OF VAPOR-LIQUID EQUILIBRIUM PHASE DISTRIBUTION RATIOS OF PETROLEUM OILS
                                                                                                        *AMIR-YEGANEH, A.
A047 54 095   ABSORPTION-OXIDATION PROCESSES IN DISPERSED MEDIA                                         *ANDERSON, L. B.
A048 40 014   VOID VOLUME AND FLOW RESISTANCE OF BEDS OF PARTICLES                                      *ANDERSON, D. C., JR.
A049 59 130   MUTUAL DIFFUSION IN ASSOCIATED BINARY LIQUID MIXTURES                                     *ANDERSON, DONALD KEITH
A050 47 033   STUDY OF METHODS FOR PROCESSING TALL OIL                                                  *ANDERSON, F. A.
A051 53 025   EVALUATION OF CATALYSTS FOR HYDROCARBON OXIDATION                                         *ANDERSON, J. E.
A052 55 037   MASS TRANSFER IN A DISTILLATION COLUMN                                                    *ANDERSON, J. E.
A053 50 025   PREPARATION OF NITROGENOUS FERTILIZERS BY TREATMENT OF CELLULOSIC MATERIALS WITH AMMONIA
                                                                                                        *ANDERSON, J. W.
A054 49 131   NORMAL BURNING VELOCITIES AND FLAME TEMPERATURES OF LAMINAR PROPANE AIR FLAMES FORM STROBOSCOPICALLY ILLUMINATED PART
             ICLE TRACKS                                                                                *ANDERSON, JOHN WILLIAMS
A055 41 131   KINETICS OF THE HYDROGENATION OF ISO-OCTYLENE                                             *ANDERSON, NILS KENNETH
A056 62 130   THERMODYNAMIC STUDIES IN THE SYSTEM CELLULOSE- WATER, STUDIES IN THE SYSTEM COTTON LINTERS-WATER
                                                                                                        *ANDERSON, NILS THEODORE
A057 53 060   PRESSURE DROPS ACROSS SUBMERGED ORIFICES WITH PSEUDO-PLASTIC NON-NEWTONIAN FLUIDS         *ANDERSON, R. A.
A058 61 083   PHYSICOCHEMICAL PROPERTIES OF POLAR-NONPOLAR LIQUID MIXTURES                              *ANDERSON, RALPH
A059 38 037   INTERFACIAL TENSION BY PENDANT DROPS                                                      *ANDREAS, J. M.
A060 42 124   VAPOR-LIQUID EQUILIBRIA N-HEPTANE-SOLVENT                                                 *ANDRES, DAVID
A061 55 025   RECOVERY OF URANIUM FROM SUPERPHOSPHATE                                                   *ANDRESEN, A. W.
A062 52 001   THE FORMATION OF CHEMICAL FILM DEPOSITS ON ALUMINUM SURFACES                              *ANDREWS, ROBERT VINCENT
A063 60 131   HYDROGENATION WITH PALLADIUM DIAPHRAGMS                                                   *ANDRUS, ORRIN E.
A064 52 026   AN EQUATION FOR THE ADSORPTION WAVE                                                       *ANGULO, WALTER JOHN
A065 61 102   THE ELECTROLYSIS OF SOME LIQUID ALLOYS                                                    *ANGUS, JOHN C.
A066 62 057   CHARACTERIZATION OF MULTIPLE VARIABLE PROCESS SYSTEMS FROM RANDOM INPUTS                  *ANGUS, RICHARD N.
A067 53 144   HEAT TRANSFER IN A FLUIDIZED SOLIDS SYSTEM                                                *ANTON, J. R.
A068 39 037   HYDRATION OF ETHYLENE BY MEANS OF DILUTE MINERAL ACIDS AT HIGH PRESSURES                  *ANTONIO, A. L.
A069 53 089   REACTION, FLOW, AND RADIATION IN ENCLOSED, PILOTSTABILIZED FLAMES AT LOW PRESSURE AND HIGH VELOCITIES
                                                                                                        *ARCHER, D. H.
A070 52 058   REACTION KINETICS AND HEAT TRANSFER IN PACKED BED                                         *ARGO, W. B.
```

thesD782
A FORTRAN program for permuted title ind
3 2768 000 98563 4
DUDLEY KNOX LIBRARY